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UNIVERSITY DEVELOPMENT IN GREAT BRITAIN

THE need for more effective organisation in the universities of Great Britain for the interchange of views at all levels and in all the fields concerned has been recognized in the Barlow Report and also in reports from the Parliamentary and Scientific Committee, Association of University Teachers and other bodies. The last report from the Parliamentary and Scientific Committee suggested that the annual conference of representatives of the different universities and of the Association of University Teachers might well provide the basis for some such more permanent and active means. If this conference set up standing committees and invited specialist advice from outside the universities, it might become the active and influential consultative body which has long been needed in university affairs, and to provide which a Universities Council had previously been recommended by the Parliamentary and Scientific Committee as well as by the Association of University Teachers.

Such a joint meeting did, in fact, take place in September 1946 at the invitation of the Committee of Vice-Chancellors and Principals, and it is understood, according to Sir Ernest Simon, that a similar representative universities council will meet this year. This is a step in the right direction, and it is important because, although the Government has already announced new and extended terms of reference for the University Grants Committee, the ambitious programme of university expansion visualized in the Barlow Report on Scientific Man-power and in the report of the Parliamentary and Scientific Committee can only succeed if there is collaboration in shaping policy all the way through the university world. Moreover, if such expansion is to take place without loss of independence on the part of the universities, and the University Grants Committee is to exercise more positive functions, the universities must evolve a satisfactory organisation of their own.

For this reason "A Note of University Policy and Finance in the Decennium 1947–56", which was prepared in July 1946 by the Committee of Vice-Chancellors and Principals, in order to present to the University Grants Committee the collective views of the vice-chancellors of British universities on certain important issues, both of policy and finance, which seemed to arise from the succession of official reports dealing with various aspects of university activity, is a document of outstanding interest and importance. According to a statement by Sir Hector Hetherington, chairman of this Committee, published in the *Universities Quarterly* of February, the note is not a private document, and copies have been furnished to each university for distribution and use as might be thought fit. The first part of the note deals with questions of administration. Part 2 deals with finance, and concludes that the proportion of university income to be found from Government services will be increased from roughly one third to three quarters in the next few years. Part 3 dis-

cusses the future relations of the Government and the universities in Great Britain.

In this part of the note it is stated that the universities entirely accept the view that the Government has not only the right, but also the duty, of satisfying itself that every field of study which in the national interest ought to be cultivated in Great Britain is in fact adequately provided for in the university system, and that the resources which are placed at the disposal of the universities are being used with full regard both to efficiency and to economy. In the view of the vice-chancellors, therefore, the universities may properly be expected not only individually to make proper use of the resources entrusted to them, but also collectively to devise and execute policies calculated to serve the national interest. In that task, both individually and collectively, the universities would be glad to have a greater measure of guidance from the Government than until quite recent days they have been accustomed to receive.

Pointing out that from its foundation the University Grants Committee has exercised a positive influence on the policy of every university, the note states that in the last twenty years probably no university has undertaken any important development without full consultation with the Committee and its officers. The universities have always recognized that inevitably and rightly the Committee has the duty, in its financial decisions, of basing its judgment on the merits of their policies. Hence the vice-chancellors would be glad if the University Grants Committee were formally authorized and equipped to undertake surveys, in all the main fields of university activity, designed to secure that as a whole the universities are meeting the whole range of national need for higher teaching and research.

The vice-chancellors emphasize their belief that it is common ground that the universities should continue to be in the fullest sense of the word self-governing societies, accountable for what they do or fail to do, properly subject to criticism, and affected in their fortunes by the public judgment of their policies; but in the last resort, their own masters. The fundamental duty of the university teacher, in his own field of study and inquiry, to pursue and to communicate with the utmost objectivity such measure of truth as he can attain, and the importance in a free society of safeguarding that fundamental truth from any risk of abridgment, are well stressed. While, however, the University Grants Committee will need to call upon the services of many experts in different fields and to add to its secretariat and even to the number of its whole-time stipendiary members, the vice-chancellors do not wish to see any fundamental change in the size or character of the Committee. The Committee is probably already near the limit of numbers for an effective working body, and the vice-chancellors believe that it will best serve its purpose if it continues to be composed as at present largely of members of distinguished academic experience selected for their personal fitness, and not in a representative capacity, giving part-time service for a period of years. An acceleration of techniques already in some degree in operation is regarded as the primary need.

An addendum from Sir Richard Livingstone, who was not present at the discussion on this part of the note, records his own view that the University Grants Committee should survey the university system of Great Britain in order to secure that the universities of the country cover the necessary fields of study, so that the Committee might give such advice to the universities as it believes necessary. With this help, Sir Richard thinks that the universities can and should be trusted to take such measures as the interest of the country and the needs of learning and education dictate.

From one point of view, this part of the vice-chancellors' note, although the shortest, is the most important; but there are certain points in the preceding sections which deserve to be noted also. Starting from the report of the Barlow Committee, the vice-chancellors comment on the divergence between claims upon university man-power presented by the Hankey and by the Barlow Committees. While the universities are both willing and ready to meet, to the best of their ability and from the resources made available to them, both new and increased demands, provided the demands are in the national interest and are not incompatible with activities appropriate to the university field, they are not in a position to judge finally as to the order in which priorities would best accord with the nation's needs; nor can they estimate, on a long-term plan, how far demands upon them put forward as immediately necessary are likely to remain permanent. On the need for doubling the pre-war number of graduates in science, the vice-chancellors hold that in no single university should a great increase in one major faculty be unaccompanied by corresponding increases in the other major faculties. Again, in insisting upon the need for such balance in expansion, the vice-chancellors also observe that the improvement of the universities requires a first place in the programme of educational expansion; and they are reserved on the question as to whether there is a sufficient proportion of innate ability in the population to provide double the pre-war number of students able to profit by a university education. The provision for expansion, in their view, would best be made by expanding existing institutions properly rather than by founding a new university, at least in the first decade.

The second and longest part of the vice-chancellors' note is that dealing with finance. This covers both capital outlay and recurrent expenditure, as well as discussing the necessary priorities in man-power and materials. The capital aggregate of the needs reported by each university to the University Grants Committee in March 1944 was £28 million on a 1938–39 basis of costs, a figure for which the vice-chancellors now provisionally substitute £45 million, or, translated into 1947 probable building costs, something of the order of £80 million, to be spent by the end of the decade 1947–56. For this purpose the vice-chancellors advocate the creation of a Treasury fund, secured by the Government in advance to the

University Grants Committee, so that the universities shall know definitely what capital outlay they each can make during the first five years of the decade, and approximately what further capital outlay they can make collectively during the second five years. The apportionment of this latter sum among the universities should be made by the University Grants Committee before the second quinquennium arrives.

This method of capital finance is urged by the vice-chancellors independently of the level at which expansion takes place, and they also press as essential for continuous development adequate priorities in building material, man-power for building and licences, *pari passu* with the national housing programme in 1947. Private benefactions can only form a small percentage of the total capital now required by the universities for sites, buildings and permanent equipment. As regards recurrent expenditure, the vice-chancellors consider not only the call for expansion but also the incidental factors such as the increased cost of equipment and materials for teaching and research, both books and apparatus, the need for upward revision of salaries, the increased expense of halls of residences, and, as already indicated, they reach the conclusion that if the universities are to meet the national needs of the decade, their pre-war combined annual revenue must be trebled; and of this total revenue, three quarters will have to be found from Government sources by way of the University Grants Committee.

In a written reply in the House of Commons on March 10, the Chancellor of the Exchequer stated that he proposes to resume the pre-war practice of settling Exchequer grants to the universities for periods of five years, and that Parliament will be asked to provide recurrent grants rising from £9,000,000 for the academic year 1947–48 to £9,970,000 for 1948–49, and then by annual increments to £11,920,000 for 1951–52. These figures exclude the grant of £500,000 now made to teaching hospitals, the amount of which for future years has not yet been determined, and they also exclude grants for agricultural education, responsibility for which will pass to the University Grants Committee after the current year. The Chancellor has also accepted the estimate of that Committee for non-recurrent grants during the quinquennium of £40 million for new buildings and £10 million for sites, existing buildings and new equipment. The Chancellor stated that he will do his best to meet the estimate; even allowing for a high degree of priority, however, the Minister of Works considers that universities will be unable to undertake more than £30 million of new buildings during the quinquennium.

This reply shows that the Chancellor is prepared to go a fair way to meet the views expressed by the vice-chancellors in their note, and further evidence of his general attitude is provided in a letter to Sir W. W. Wakefield, deputy chairman of the Parliamentary and Scientific Committee, concerning its report on "Universities and the Increase of Scientific Man-Power". Mr. Dalton believes that that report under-estimates the number of scientific workers who will be available in 1955 and 1965, and over-estimates the number of retirements in the second decade. The Chancellor estimates that there will be 104,000 scientific workers by 1965, after allowing for the loss of 18,000 from retirement and 5,000 from choice. Again, he doubts the practicability of effecting university expansion to the extent suggested in that report or in that of the Barlow Committee, and accepts rather the estimate, based on investigations made by the University Grants Committee, of 88,000 as the maximum number of science graduates in the next ten years if academic standards are not to be lowered.

The Chancellor also indicated that he shared the views of the Parliamentary and Scientific Committee and also of the vice-chancellors on the inadvisability of founding a new university at this stage. He is in sympathy with the upgrading of some university colleges to university standard, and is clearly open-minded on the question of developing several universities out of constituent colleges of the University of London. He is dubious as to the wisdom of bringing certain technical colleges to university standard, and does not agree with the Parliamentary and Scientific Committee that existing salary scales will be a deterrent to the recruitment of university teachers.

While this letter makes evident the anomaly in the higher educational system of Great Britain, which places the development of universities and colleges of technology under different ministers, the Chancellor's observations are distinctly encouraging and promise all that could be expected at the moment. Furthermore, the vice-chancellors' note shows that there is full support within the universities for the action the Government has already taken in extending the functions of the University Grants Committee. This frank recognition of the necessity of some overall attempt to plan the resources and expansion of the universities in accordance with national needs, broadly understood, is accompanied by the statement that the vice-chancellors would not exempt the universities themselves from the necessity of playing their own part in the co-operative planning of the whole university system. It falls to them, at least as much as to the University Grants Committee, to devise methods of working together to ensure the fulfilment of their common task. Some matters call for central discussion on the national scale, while others are best dealt with regionally. There are also the important and complex relations with the Dominion universities, with the higher educational service of the Colonies and with the universities of the United States and of Europe.

The vice-chancellors have recently appointed two committees, drawn from experts in particular problems outside the membership of the Committee, to report on matters of general consequence to the universities. Other similar studies will be undertaken as speedily as conditions allow. In this way and in others, the vice-chancellors hope that the universities of Britain will be able to co-operate with one another and with the University Grants Committee in the planning and development of a full range of university service.

It seems clear, therefore, from this note that the universities are prepared to participate in planning their future expansion and development, and that they are also unanimous that the Committee of Vice-Chancellors and Principals should play the part of a national negotiating body in which they have full confidence. The Committee is also understood to be inquiring at the present time into the whole question of halls of residence for the modern universities; and it should also be noted that the universities have already been asked to quadruple their grants to the Universities Bureau of the British Empire, a body which finances the Committee of Vice-Chancellors and Principals and provides its secretariat.

Clearly the Committee cannot work without a strong secretariat, as was pointed out by Sir Ernest Simon in his pamphlet "The Development of British Universities" three years ago, and as has since been emphasized by the Parliamentary and Scientific Committee in its latest report.

Some of the proposals for expansion of the individual universities and suggestions for the establishment of new universities, at least as currently reported in the Press, appear to show little appreciation of the importance of planning the national resources for university development to the best general advantage. That manifestly is the desire and intention of the vice-chancellors and of the Chancellor of the Exchequer; and while both have shown the desire to plan resources in this way, the statements issued assure to the universities the sole responsibility of determining trends of research and the training of scientific workers, and there is to be no interference with research funds. These statements indicate that university development in Great Britain is likely to proceed on sound lines, with sufficient Government support and without undue outside interference.

LAST TESTAMENT OF A PHYSICIST

Fundamental Theory

By Sir A. S. Eddington. Pp. viii + 292. (Cambridge: At the University Press, 1946.) 25*s*. net.

SIR ARTHUR EDDINGTON died in 1944. He left, almost completed, a manuscript entitled "Fundamental Theory". Sir Edmund Whittaker was invited by Miss Eddington and the syndics of the Cambridge University Press to supervise the publication of this manuscript in book form, and the volume under review is the result. Sir Edmund Whittaker has added to what must have been no light task by contributing to the *Mathematical Gazette* (29, 137–44, Oct. 1945) a clear introductory account of the material in the volume. Prof. E. T. Copson, of Dundee, and Prof. G. Temple, of King's College, London, have assisted Whittaker in the proof-reading. The gratitude of all who knew Eddington, either personally or through his writings, is due to the mathematicians mentioned for preserving for posterity a remarkable document, the last scientific testament of one of the profoundest thinkers of our time.

The scope of the book is not properly indicated by its title, since it does not deal with the foundations of physical science in the ordinary sense. It should have been called, perhaps, "Advanced Theory", for it assumes not merely a knowledge of, but also the actual conclusions of, the general theory of relativity and the quantum theory. Its aim is to weld the two into a single discipline, and in the course of the attempt it claims to complete what for years had been a main theme of Eddington's doctrines, namely, the calculation of the molar, microscopic and nuclear constants of Nature in terms of pure numbers, by analysis of the group-structure of the physical universe. The first five chapters reproduce almost verbatim the text of his Dublin Lectures of 1943, "The Combination of Relativity Theory and Quantum Theory" (*Dublin Inst. Adv. Studies*, Series A, No. 2), and are devoted to the uncertainty of the reference frame and what Eddington calls *multiplicity factors*; the next three reproduce in terser form the substance of his "Relativity Theory of Protons and Electrons" (Cambridge, 1936), and are devoted to an exposition of his very beautiful sixteen-dimensional non-commutative calculus, by which he claims to represent all the characteristics, mechanical, electrical and magnetic, of *particles* considered as *carriers of variates*; the remaining four chapters apply the sedenion analysis thus developed to such physical problems as the levels of the hydrogen atom, the masses of the proton, neutron, deuteron and helium nucleus, the separation constant of isobars and the mass of the mesotron, and to such more general questions as the wave equation, the electromagnetic field and radiation. As an appendix there is reprinted Eddington's paper in the Cambridge Philosophical Society's *Proceedings* (40; 1944) on the evaluation of the cosmical number N.

The volume is brilliantly written; but the physical argumentation is so unfamiliar, so involved, so perpetually under revision and correction, that it is extremely hard to extract from it any convincing proof of any of Eddington's most famous formulæ. When I say "brilliantly written", I mean that it is enlivened with sallies of a most vivid description in nearly every chapter, showing how the unregenerate Eddington kept up his spirits and his self-confidence to the very end in spite of all the criticisms he incurred; as, for example, when he writes (p. 189) "to deny that a neutron is composed of a proton and an electron is as pedantic as to deny that water is composed of oxygen and hydrogen"; or (p. 162) "broadly speaking there is no three-particle theory in physics"; or (p. 131) "the only kind of individuality known in physics is the pseudo-individuality conferred by idem-potency"; or (p. 30) "the term particle survives in modern physics but very little of its classical meaning remains"; or (p. 19) "quantisation is a distinctively *electrical* phenomenon"; or (p. 89) "the initial fallacy in recent investigations of white-dwarf matter . . . continues to work devastation in astronomy"; or (p. 76) (a remark I strongly object to, as in making it Eddington was behaving like an ostrich) "the infinite universe has long been dead and buried; and those who insist on digging up the corpse must expect to be haunted".

To come to more serious criticisms. Those who seek a compact proof that the fine-structure constant $2\pi e^2/hc$ has the exact value 1/137 will have a very difficult time of it in this book. One first has to master the use Eddington makes of his multiplicity factors k, which are somewhat disarmingly defined as the number of dimensions of a certain phase space; then his procedure of *stabilization*, which is a sort of wand which he waves in order to suppress

inconvenient degrees of freedom, and so to alter the multiplicity factors; then one has to overcome all one's prejudices in swallowing a formula on p. 29, that masses are *inversely* as multiplicity factors, whereas, with Eddington's repeated identification of mass with energy, one would have expected the energy of a particle to be directly, not inversely, proportional to the number of its degrees of freedom in phase space. After these troublesome preliminaries one reads to §20, entitled "The Fine-Structure Constant", only to find that there merely plausible considerations are advanced for the assignment of the number 137 to the ratio of two "atoms of action", and that the theoretical derivation of the relation is postponed to §33. Lastly, one cannot follow §33 at all. These difficulties re-occur throughout the book.

Still severer criticism must be made of one of Eddington's derivations of what he calls "the central formula of unified theory" (p. 81, equation 40.8). This is the formula:

$$M = \frac{136}{10}\,\frac{3}{4}\,\beta^{1/6}\,\frac{h}{2\pi}\,\frac{\sqrt{(4/5)N}}{cR_0},$$

where 136 and 10 are multiplicity factors, β is the "Bond factor", M is the mass of the hydrogen atom, R_0 is the radius of the Einstein spherical universe, and N ($=3/2.136.2^{256}$), the cosmical number, is the number of protons and electrons in the universe. He first derives the formula by considerations involving various fictitious particles—the standard carrier, extracules, intracules, hydrocules. These arguments I cannot follow. He then remarks: "in the next three sections the same formula will be derived by an entirely different method". This method is an application of one of his aphorisms, "exclusion is a wave-mechanical substitute for gravitation", and one's spirits begin to rise, because the method consists in applying to the *uranoid*, or neutral Einstein universe, the Pauli exclusion principle as used, for example, in the Thomas–Fermi atom, or in the determination of the equation of state of a degenerate gas, as applied to super-dense stars, and with this, at least, an astrophysicist is familiar. Eddington does, in fact, apply the usual method, of filling cells in phase space, and one expects to see the 'central formula' emerge. Unfortunately for Eddington's aphorism, it emerges with the wrong power of N, in fact with an extra unwanted factor $N^{1/3}$, which makes nonsense of the so-called independent derivation. But Eddington is not one whit abashed. He calmly puts $\mu_1 = \mu_0(\frac{1}{2}N)^{1/3}$, where μ_0 is the mass-constant of an extracule, and presents us with a formula, (41.41), supposed to be equivalent to the central formula, but with the unwanted power of N absorbed into one of the symbols. It is difficult to understand how Eddington could convince himself that this palpable fudge amounts to an independent proof of his 'central formula' by the 'gravitation equals exclusion' principle. But when Eddington had the bit between his teeth, no mere mathematical inconsistency ever held him back: witness, for example, his erroneous treatment of stellar opacity, as I have shown elsewhere.

Eddington's 'uranoid' plays the same part in his theory as the 'substratum' in kinematical relativity. In both theories it is an idealized model of the smoothed-out universe, and as such is the environment, the scene, the stage upon which phenomena are enacted or objects isolated. But whereas the substratum unchangingly incorporates the essential element of expansion, or recession, Eddington's uranoid is static—non-expanding and at zero temperature. Eddington admits (p. 93) that both his uranoid and another environment he introduces called 'the planoid' "differ widely from the actual expanding universe". Eddington has been, in fact, inclined to criticize notions which competed with his own, and then, no doubt unconsciously, develop similar notions in his own work. Another example: on p. 14 he correctly explains that by adopting two conventions as to units, namely, $c = 1$ and $8\pi\kappa(h/2\pi)^2 = 1$, he is left with one unit at his disposal, "which may be taken to be a length, mass, density or any other combination". "If, for example, it is taken to be a length", every physical quantity has a single dimension index which shows how it varies with the unit of length. But why did he not go on to admit that it might be taken to be a *time*? Why did he unsparingly criticize and reject my own similar procedure when I made physical quantities depend only on the unit of time?

His actual reason for taking $c = 1$ is perverse and misguided: "by taking the velocity of light to be unity, we avoid the obsolete and troublesome distinction between mass and energy" (p. 14). It is as though one should justify measuring pressures in centimetres on the ground of avoiding the obsolete and troublesome distinction between pressure and length. The treatment of energy as mass obscures the fundamental fact that energy has to be defined through mechanical work, and the whole theory of the momentum-energy 4-vector shakes visibly as soon as we see that energy is really a 4-scalar, as is necessary (among other reasons) for the conservation of energy to have a meaning.

Leaving aside these criticisms of detail, one has to pass some general judgment on the work as a whole. It must be recognized that Eddington has invented a mathematical technique, a logic of reasoning and a language of formulation which are as yet strange to most of us, and which no doubt conceal arguments and considerations which would be accepted if less individually expressed. That his work runs counter to some of current physics he was well aware. The antagonism is evident from the outset of the book (p. 9), for he treats the non-Coulombian energy of two electrical particles as Ae^{-r^2/k^2}, while on Yukawa's formulation and on kinematic relativity exponential terms of the type $e^{\pm r^2/mc^2\tau}$ are involved (*Phil. Mag.*, **34**, 244; 1943). Thus the whole use which he makes of the Gaussian theory of errors is out of line with current electrical theory. Nevertheless, the agreements he gets with the observed constants of Nature are impressive, though (to my mind) calculating the recession-speed of the galaxies is only equivalent to calculating the age of the universe at the moment we happen to be viewing it. I think that Eddington's repeated insertions of lists of constants calculated from 'fundamental theory' were made more to convince his critics than because he himself attached over-riding importance to them. It was the landscape of his theory that most appealed to him. Witness, for example, his beautiful geophysical analogy (p. 220): "The term uranoid was derived from analogy with the geoid; the field momentum and energy is the isostatic compensation of the mountains (object particles) added to the uranoid. We have not hitherto used this analogy because geodesy is not accustomed to deal with mountains which are 'unidentified members of a large assembly'. But we are now preparing, formally at least, to deal with individual

mountains; and an important step is as far as possible to attach to each individual its own isostatic compensation, instead of the collective compensation that suffices in scale-free physics. . . . The wave-function is a self-contained unit which can be dumped anywhere on the uranoid without upsetting the equilibrium of the uranoid particles."

Eddington's last scientific testament has all the marks of the production of a man of genius, not excluding tiresomeness; whether or no it will survive as a great scientific work, it is certainly a notable work of art.

E. A. MILNE

TECHNICAL AND SCIENTIFIC ASPECTS OF ATOMIC ENERGY

Science News, 2

Atomic Energy Number. Edited by Prof. R. E. Peierls and John Enogat. Pp. viii+168+15 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1947.) 1*s.* net.

MUCH has appeared in print and been heard in recent weeks about atomic energy; but an authoritative survey of the technical and scientific development of the past few years in the field of nuclear physics is still lacking. The second volume of Penguin Science News is, therefore, very welcome, because it is a collection of seven articles, written by prominent nuclear scientific workers, covering some of the more important technical and scientific aspects of the subject of atomic energy. The question of international control, and the political and social consequences are not dealt with specifically. The authors, some as members of the British and others of the American staff, were at one time engaged together on the atomic bomb project at Los Alamos, and thus write with first-hand knowledge of the problems which were tackled and solved in the production of atomic energy for military purposes. Each of the seven articles is self-contained and may be studied separately.

The subject-matter is presented in an interesting fashion, and can be readily understood by the non-specialist but scientific reader. The first article, by Prof. R. E. Peierls, is a general survey of the whole field and forms a key to the rest. H. A. Bethe follows with a description of the structure of atoms and nuclei, and H. L. Anderson shows how atomic power was tamed and plutonium produced. "The Physics of the Bomb", by P. Morrison, gives not only a clear description of the chain reactor which constitutes the atomic bomb, but also a very vivid picture of what happens during and immediately after the explosion. Some of the peace-time applications of the liberation of nuclear energy using radioactive tracers are dealt with by M. Argo and E. Teller, and in the final article O.R. Frisch reviews, with numerous diagrams, some of the techniques used in nuclear research.

Considering the high price of present-day scientific text-books, it is remarkable that this collection of articles can be produced for so small a cost as one shilling. It is true that the diagrams, though clear, are too small and that the plates leave much to be desired both from the point of view of subject and reproduction; but these are very minor defects in a book which, undoubtedly, will be widely read and which will be in great demand—probably in greater demand than the limited supply will be able to satisfy.

S. WEINTROUB

D.D.T. FROM AN AMERICAN POINT OF VIEW

D.D.T. and the Insect Problem

By James C. Leary, Dr. William I. Fishbein and Lawrence C. Salter. Pp. vii+176. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 12*s.* 6*d.*

THE insecticidal property of D.D.T. was undoubtedly a great discovery, and its application during the War, at a time when the supplies of other insecticides were inadequate after the capture by the Japanese of the derris-producing areas and the cutting off of supplies of pyrethrum, was an important contribution to Allied victory. D.D.T. will have many uses in peace-time, and it is therefore important that its properties should be widely known so that it may be used to the best advantage. In Britain the book "D.D.T.: the Synthetic Insecticide" (reviewed in *Nature*, 158, 359; 1946), by West and Campbell, was generally welcomed; the authors have been themselves engaged in insecticide research, and have made important contributions to knowledge concerning D.D.T. Now a book on apparently similar lines comes from the United States. Its authors are not research workers; one is a medically qualified epidemiologist, but from internal evidence one judges that the book was mainly written by his colleagues, who are both journalists. Although the book looks at first sight as if it were a scientific compilation, it is in fact popularized journalism with some scientific data thrown in rather uncritically for effect.

D.D.T. was first used in Switzerland, and many of the 'classical' experiments were carried out in that country. Later, during the War, a great deal of experimental work was done both in the United States and in Britain. Unfortunately, the British authorities were rather more reluctant than the American to allow publication of the results of this work, so the literature contains a preponderance of American papers. Nevertheless, many important British contributions have been published. In West and Campbell's book the bibliography is reasonably complete up to 1945, when it went to press; there are many Swiss and British references, but the majority listed are American. Leary, Fishbein and Salter also publish a bibliography. It contains no references to Swiss work (they do acknowledge in the text that a little preliminary research was done in Switzerland), and the only British contributions appear to be three short notes in the *British Medical Journal* describing cases of individuals poisoned by excessive exposure or by drinking D.D.T. solutions. Every other reference is American.

Notwithstanding its trans-Atlantic bias, "D.D.T. and the Insect Problem" might still be a useful book if it were an accurate and readable summary of current knowledge. It is not. It contains many sweeping and controversial statements; thus, for example, infectious encephalitis (confusingly called "Sleeping Sickness") is definitely stated to be carried by a culicine mosquito. Its style may be gathered from a typical quotation, from the section on typhus control: "Neapolitan brides finally got so they laughed when D.D.T. replaced rice at weddings". So much first-class research has been done in the United States on D.D.T., and there are so many good 'popularizers' in that country, that it is a pity that a better book has not been produced to fill what must be a widely felt need.

KENNETH MELLANBY

EXPERIMENTS ON THE STIMULATION OF CLOUDS TO PRODUCE RAIN

By E. B. KRAUS and P. SQUIRES

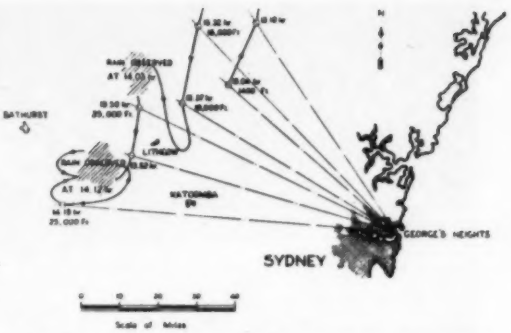
Division of Radiophysics, Council for Scientific and Industrial Research, Commonwealth of Australia

IN 1933 Bergeron[1] postulated that rain falls only from clouds which contain both water drops and ice crystals. Natural cumulus clouds at temperatures above −13° C. often contain only supercooled water drops and no ice crystals. If a method existed of planting crystal 'germs' in these clouds, the crystals would grow into large snowflakes at the expense of the water drops and eventually fall as rain or snow.

During a visit to Schenectady in July 1946, one of us had the opportunity of witnessing Schaeffer's experiments in which ice crystals were produced artificially in the laboratory by the sudden cooling of moist air[2]. These experiments can be related to a quantitative theory which has been developed by Volmer[3]. They suggested a possible method of planting ice particles in natural clouds. Newspaper reports since that date have indicated that Langmuir and Schaeffer have succeeded in stimulating the precipitation of snow from supercooled clouds by dropping 'dry ice' pellets into them from aircraft.

Experiments have now been carried out in Australia with the view of investigating the artificial stimulation of rain. At the time of writing eight different clouds have been treated. Radar observations have indicated that rain formed inside the cloud on six occasions, and on four of these heavy rain was observed visually to reach the ground. One case is doubtful; and a single negative result was obtained when a cloud, which reached only about 1,000 ft. above freezing-level, was infected. All other clouds had a vertical extent of more than 10,000 ft., of which at least 4,000 ft. were above freezing-level.

One of the most spectacular tests was carried out on February 5, 1947. On that day equatorial air was flowing slowly over the east coast of Australia from a generally north-easterly direction. Inland



RADAR PLOT OF THE AIRCRAFT TRACK AND THE TWO AREAS WHERE RAIN ECHOES WERE OBSERVED TO FORM

areas of eastern New South Wales were covered by seven- to eight-tenths of cumulus cloud (Fig. 1). The coastal plain and the Pacific were cloudless, as seen in the background on Fig. 2. The cloud base was at 11,000 ft., the freezing-level at 18,000 ft. and the top of the clouds uniformly at 23,000 ft.

At 13.45 hr., 100 lb. of granulated carbon dioxide was dropped into a cloud the top of which was slightly below the general level. After five minutes, no visual results were observed. The aircraft flew on, and another test was carried out about twenty miles to the south-west. At 13.56 hr. 150 lb. of 'dry ice' was dropped into a second cloud. The aircraft circled, and in less than five minutes rain echoes from within the cloud were recorded on the aircraft's 10 cm. radar equipment. After the release of a further 150 lb. of 'dry ice', the echoes grew in intensity, and twenty-one minutes after the cloud was first infected an oblique view was obtained which showed heavy rain coming from the base of the cloud. Forty-five minutes later the aircraft descended to 8,000 ft., well below the cloud base, and a pillar of rain covering at least twenty square miles was then seen to reach the ground. Later interrogation of farmers in that vicinity confirmed the occurrence of an isolated rain storm.

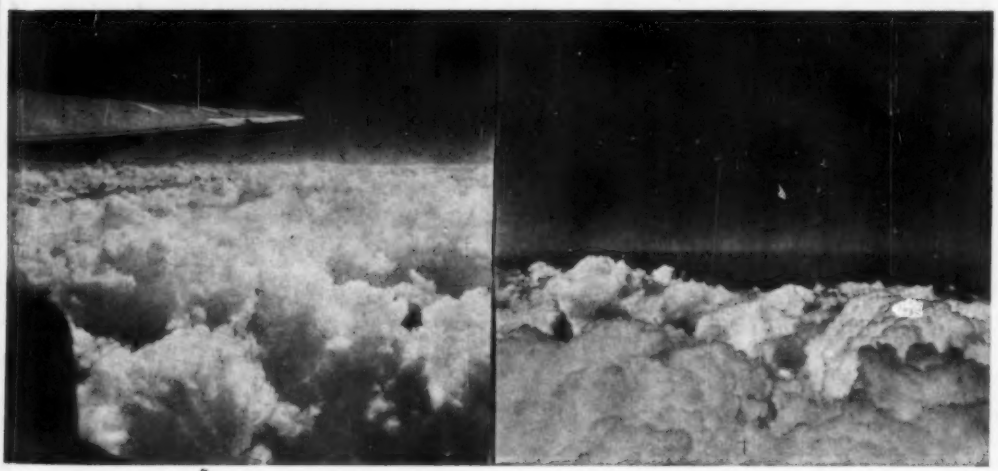


Fig. 1. INLAND CLOUD TYPES BEFORE 'DRY ICE' WAS DROPPED

Fig. 2. GENERAL SITUATION LOOKING EAST OVER THE PACIFIC

Fig. 3. Nine minutes after the release of 'dry ice'

Fig. 4. Thirteen minutes after the release of 'dry ice'

The flight was observed by a 25 cm. radar set at George's Heights in Sydney. The accompanying radar plot gives the measured position and height of the aircraft at different times. The track taken by the aircraft, while circling the dropping zones, has been omitted. Rain echoes appeared on the radar screen in the area of the first drop at 14.03 hr., that is, 18 min. after the release of 'dry ice'. In the second dropping zone, rain echoes were first sighted at 14.12 hr., or 16 min. after the release. It persisted for the rest of the afternoon. No other rain was observed within 100 miles of the aircraft.

Visual observation above the clouds showed a spectacular growth of the second infected cloud. Figs. 3 and 4 give its aspect 9 min. and 13 min. after the dropping. Later, a narrow towering anvil formed (Figs. 5 and 6). Another smaller tower was seen approximately in the direction where the first drop had been made. These were the only two clouds which rose above the general level of the other tops. It is estimated that the bigger one reached a height of perhaps 40,000 ft. The line of frontal clouds, which can be seen along the horizon on some of the photographs, was about 180 miles to the south.

The remarkable rise of the infected cloud may have been due to the liberated heat of fusion. The atmosphere above 23,000 ft. was presumably unstable for changes involving the transformation from vapour to ice (saturated adiabatic relative to ice), although it was stable with regard to condensation processes (saturated adiabatic relative to water). We do not know how frequently such atmospheric conditions occur.

It is emphasized that the meteorological conditions chosen were those which we believed to be most favourable. Before practical application of the results is possible, it will be necessary to establish the minimum conditions and to find out how often they are likely to occur. The phenomenon is related to the temperature distribution, the available amount

Fig. 5. The small anvil which formed after about twenty minutes

Fig. 6. The fully developed anvil

of water in all three phases, the vertical velocity and the turbulent transfer of heat. Some of these factors have never been established inside clouds. Others can only be measured with great difficulty. Much further research is required.

The experiments are part of the programme of the Council for Scientific and Industrial Research, Commonwealth of Australia, in which the Divisions of Physics and Radiophysics are collaborating. We wish to acknowledge the work of Messrs. Harper and Kemp of the Division of Physics in making laboratory experiments which provided data for the full-scale tests. We wish also to make acknowledgment to the crews of No. 82 Wing, Royal Australian Air Force, who were responsible for the flying, to Mr. Heffernan who took part in most of the flights, and to Dr. E. G. Bowen, Chief of the Division of Radiophysics, for his enthusiastic support.

[1] Union Géodesique et Géophysique International (Lisbon, 1933).
[2] Science Newsletter, Washington (November 23, 1946).
[3] Volmer, "Kinetik der Phasenbildung", reprinted by Edwards Brothers, Ann Arbor, Michigan.

TOXIC ORGANO-LEAD COMPOUNDS

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AND
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THIS work began in Cambridge in 1939 with the original purpose of preparing compounds of the type PbR_4 which might be toxic by inhalation. It should be noted that, at that time, supplies of arsenic in Great Britain were very much reduced, whereas lead was readily available. Compounds which we contemplated preparing were $(C_2H_5)_2Pb(CH_2CH=CH_2)_2$, $(C_2H_5)_2Pb(CH_2CH_2Cl)_2$ and $Pb(CH_2CH_2Cl)_4$, etc. As an intermediate, it was necessary to prepare triethyl lead chloride $(C_2H_5)_3PbCl$ in quantity, and one of us (B. C. S.), while working with this compound, developed the symptoms of a severe attack of influenza, which, however, wore off at night and returned during the day. The compound was therefore tested for sternutatory properties, and found to produce, at a concentration of one part in a million, an atmosphere in which respiration was difficult.

This discovery then gave a great impetus to the preparation of triethyl lead salts. The original intention of preparing substituted plumbanes was postponed, and the preparation and detailed examination of trialkyl lead compounds were then undertaken. Several hundred compounds were prepared, many of which were new. They were tested as potential sternutators at Cambridge, and reports on these compounds were submitted by us to the Ministry of Supply during the years 1940–41. These reports were also made available to American workers.

It was found that passing reference had been made to the irritant properties of certain trialkyl lead salts by earlier investigators, for example, Krause and Pohland[1]. Gilman and Robinson[2] had noted that sneezing was caused by dust containing triethyl lead salts. No systematic attempt, however, had ever been made to correlate potency with the nature of the constituent groupings, and no compound of high sternutatory power had been recorded. In the present work, emphasis was placed on the production of substances which had the following characteristics: (i) ease of preparation, (ii) reasonable stability, (iii) strong sternutatory action.

A full account of the methods of preparation will be given in the appropriate journals later. Many of the compounds were easily obtained in a highly crystalline pure condition, and have not deteriorated on being stored for several years.

Physiological Examination

Examination of the physiological action of these compounds on ourselves and members of the team was carried out in a glass-walled chamber of 10 c.m. capacity. The substance under test was dissolved in a suitable solvent, and dispersed in the chamber by means of a spray operated by compressed air. Suitably placed fans ensured, so far as possible, an even distribution of the material in the atmosphere inside the chamber. The human observers, four in number, entered the chamber by an air-lock as soon as spraying was complete. The times which then elapsed before irritation occurred in the nose, throat, chest, and gums were noted. Unless the substance proved to be intolerable, the observers stayed in the chamber for 10 minutes. From the data thus compiled, a toxicity rating for a given concentration could be allotted to each compound.

The first concentration to be tried was 1 molecule of the substance in 10,000,000 molecules of air, that is, about 15 mgm. of organo-lead compound were actually dispersed in the chamber. The required amount was dissolved in about 15 ml. of solvent (usually alcohol). For certain of the more potent substances, tests were carried out at concentrations of 1 : 25,000,000.

Triethyl lead chloride, $(C_2H_5)_3PbCl$, was taken as an arbitrary standard, and all other compounds were put into various categories in comparison with this standard. Thus, triethyl lead monochloroacetate, triethyl lead monobromoacetate, triethyl lead cyanate were found to produce effects similar to those produced by triethyl lead chloride at the same molecular concentration[3,4]. The following were examples of triethyl lead salts which were superior as sternutators to triethyl lead chloride:

triethyl lead acetate;
" " cyanide;
" " crotonate;
" " *iso*-valerate;
triethyl lead *p*-toluene sulphonate;
" " thiocyanate;
" " *β*-chloropropionate.

Certain triethyl lead compounds, for example, triethyl lead selenocyanide, were slightly inferior in their sternutatory effect to the standard triethyl lead chloride.

All trimethyl lead salts (for example, $(CH_3)_3PbCl$, $(CH_3)_3PbO.CO.CH_2Cl$, $(CH_3)_3Pb.O.CO.CH_2CH(CH_3)_2$) were markedly inferior, irrespective of the acid radical, to all salts of the triethyl lead series. In fact, all trimethyl lead salts produced atmospheres which caused only very mild discomfort at a concentration of 1 part in a million.

Tri-*n*-propyl Lead Salts

Regarding homologues above the triethyl series, we definitely established[3,4,5,6] that derivatives of tri-*n*-propyl lead were without exception markedly more effective than the corresponding compounds of the triethyl lead series. A falling off of potency was, however, noted in the tri-*n*-butyl series, and these

compounds were always inferior to the corresponding compounds in the tri-*n*-propyl series, but usually superior to compounds of the triethyl lead series. Tri-*iso*butyl lead salts were also usually inferior to tri-*n*-propyl lead salts.

Of the numerous tri-*n*-propyl lead salts prepared and examined the following may be mentioned:

tri-*n*-propyl lead acetate;	tri-*n*-propyl lead *n*-butyrate;
" " bromoacetate	" " *iso*-valerate
" " iodoacetate;	" " acrylate;
" " trichloroacetate	" " *o*-toluene sulphonate;
" " *β*-chloropropionate;	" " *p*-toluene sulphonate.

Of the above, tri-*n*-propyl lead acrylate[7,8] was the most potent.

Examples of tri-*n*-butyl lead salts and tri-*iso*butyl lead salts which were superior to triethyl lead chloride in respect of sternutatory properties were:

tri-*n*-butyl lead chloride	tri-*n*-butyl lead *β*-chloropropionate;
" " acetate;	" " crotonate;
" " bromoacetate;	tri-*iso*butyl lead chloride;
" " iodoacetate;	" " acetate;
" " trichloroacetate;	" " butyrate;
" " propionate	" " *p*-toluene sulphonate.

Dialkyl Lead Salts

We found that, without exception, diethyl lead salts (for example, diethyl lead dichloride $(C_2H_5)_2PbCl_2$) were almost devoid of sternutatory properties. This absence of sternutatory power was independent of the acid radical, for diethyl lead dichloride, dithiocyanate, dibenzoate, di-3 : 5-dinitrobenzoate[6] were all equally ineffective. Even in the *n*-propyl series, the di-*n*-propyl lead salts were found to possess extremely feeble sternutatory properties in spite of the fact that the *n*-propyl radical enhanced potency so markedly in the tri-*n*-propyl lead series.

A New Method for Preparing Diethyl Lead Salts

Triethyl lead salts are readily prepared by neutralizing a solution of triethyl lead hydroxide with the appropriate acid[3]:

$$(C_2H_5)_3PbOH + CH_2CH{:}CHCOOH = (C_2H_5)_3PbO.CO.CH{:}CH.CH_3 + H_2O.$$

When a plumbane is treated with a monobasic acid and silica gel, it has been found that, in some instances, the trialkyl lead salt is produced, whereas in other cases the dialkyl lead salt is formed; for example:

$$(C_2H_5)_4Pb + CH_3COOH = (C_2H_5)_3Pb.O.CO.CH_3 + C_2H_6$$
$$(C_2H_5)_4Pb + 2C_6H_5COOH = (C_2H_5)_2Pb(O.CO.C_6H_5)_2 + 2C_2H_6.$$

It is not always quite clear what governs this difference, although in some cases the strength of the acid seems to be one of the controlling factors[7]. Very frequently the analyses of the two types of salts are close, and an independent method of preparing the diethyl lead salts was obviously essential in order to establish definitely their identity.

In 1940 we showed[3] that moist sulphur dioxide reacted with lead tetraethyl producing *diethyl lead sulphite*, $(C_2H_5)_2PbSO_3$. Later, we discovered that this compound reacted smoothly with a number of acids producing diethyl lead salts:

$$(C_2H_5)_2PbSO_3 + 2CH_2ClCOOH = (C_2H_5)_2Pb(O.CO.CH_2Cl)_2 + SO_2 + H_2O.$$

The compound prepared in this way was different from the compound obtained by the action of chloroacetic acid on lead tetraethyl, and this second compound was identical with the product obtained by the neutralization of triethyl lead hydroxide by chloroacetic acid.

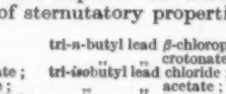
Before leaving dialkyl lead salts, mention should be made of the disproportionation of diethyl lead di-monochloroacetate[7], which we found to proceed in hot aqueous solution as follows:

$$2(C_2H_5)_2Pb(OCOCH_2Cl)_2 = (C_2H_5)_2PbOCOCH_2Cl + Pb(O.COCH_2Cl)_2 + ClCH_2COOC_2H_5.$$

Di-*n*-propyl lead diacetate behaved similarly. In view of this facile disproportionation, it is rather surprising that dialkyl lead salts are so ineffective as sternutators.

New Types of Trialkyl Lead Compounds

In addition to the simple trialkyl lead salts mentioned above, we also directed our attention to the synthesis and examination of new types of organo lead compounds[3,5], such as triethyl lead phthalimide



$(C_2H_5)_3PbN$ C_6H_4, triethyl lead ethyl sulphide, $(C_2H_5)_3PbSC_2H_5$, and triethyl lead phenyl sulphide $(C_2H_5)_3PbSC_6H_5$. The first of these compounds is a solid. The sulphides are liquids soluble in non-polar solvents and prepared from triethyl lead hydroxide and the corresponding mercaptan. Triethyl lead ethyl sulphide can be distilled under reduced pressure and possesses an odour resembling that of horseradish. All three possessed sternutatory properties similar to that shown by triethyl lead chloride. Tri-*n*-propyl lead phthalimide[5] was also prepared and, in accordance with expectation, was found to be more potent than triethyl lead phthalimide.

Sulphonamides Containing Lead

In October 1940 we prepared[3,4] a new and interesting type of compound, namely, triethyl lead *p*-toluene sulphonamide, $CH_3C_6H_4SO_2NHPb(C_2H_5)_3$. This highly crystalline compound, recrystallizable from benzene, was obtained in 73 per cent yield by heating the sodium derivative of *p*-toluene sulphonamide with triethyl lead chloride in alcoholic solution:

$$CH_3C_6H_4SO_2NHNa + ClPb(C_2H_5)_3 = CH_3C_6H_4SO_2NHPb(C_2H_5)_3 + NaCl.$$

It was found to be the best lead sternutator examined up to that time, and was intolerable at a concentration of 1 in 10,000,000.

This led to an extensive investigation of this and related compounds, and we later showed[7] that a very simple and satisfactory method of preparation consisted of mixing, in the cold, alcoholic solutions of *p*-toluene sulphonamide and of triethyl lead hydroxide, and then adding water to precipitate the substituted sulphonamide. An almost pure product was obtained even before recrystallization, and the yield was 80 per cent.

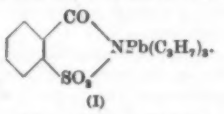
$$CH_3C_6H_4SO_2NH_2 + (C_2H_5)_3PbOH = CH_3C_6H_4SO_2NHPb(C_2H_5)_3 + H_2O.$$

In accordance with expectation, tri-*n*-propyl lead *p*-toluene sulphonamide was more potent than the triethyl compound. Similarly, tri-*n*-propyl lead benzene sulphonamide (which was obtained in 93 per cent yield from tri-*n*-propyl lead hydroxide) was a powerful sternutator, and at a concentration of 1 part in 10^7 all observers were forced to leave the chamber at the end of 40 sec.[8]. In addition to its sternutatory effect, this compound produced a pronounced irritation on the fingers and faces of some of the workers who were concerned with its prepara-

tion. Its solubility in alcohol was high (65 gm. dissolved in 100 c.c. of cold alcohol). The compound could be recovered unchanged from the alcoholic solution after six days.

A large variety of compounds of the type $RSO_2NR'PbR_3''$ were then prepared[9,10], where, for example, R = CH_3, C_6H_5, p-$NH_2C_6H_4$, and R' = H, C_6H_5, p-ClC_6H_4, p-BrC_6H_4, and R'' = C_2H_5, n-C_3H_7, etc. They were without exception good sternutators, with tri-n-propyl lead methane sulphonamide as the most potent, being extremely unpleasant at a concentration of 1 in 25,000,000. It possessed a further advantage on account of its relatively low molecular weight.

One of the most interesting compounds of this series was tri-n-propyl lead o-sulphobenzimide[9] (I), which produced intense irritation and caused the



(I)

observers to leave the chamber after 1½ min. exposure. We reported, also, that the compound, even at this dilution, produced a 'sweet taste'.

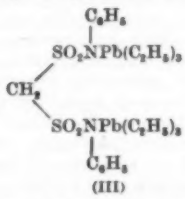
In view of the fact that the sulphonamide grouping on one hand and an unsaturated grouping on the other hand (for example, triethyl lead acrylate and tri-n-propyl lead acrylate) each independently produced an increase in sternutatory effect, it was decided to prepare triethyl lead vinyl sulphonanilide (II):

$$CH_2 = CHSO_2N(C_6H_5).Pb(C_2H_5)_3.$$

(II)

The compound was certainly one of the best sternutators of the triethyl lead series, and at a concentration of 1 in 10^7 gave an atmosphere which was scarcely tolerable. The potency, however, was not so high as might have been anticipated in view of the presence of two 'active' groups[9].

About this time we also prepared and tested methylene bis(triethyl lead sulphonanilide) (III)

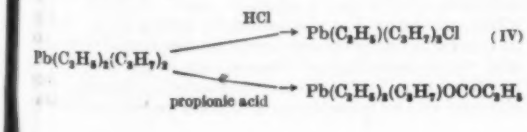


(III)

Although it was a reasonably good sternutator, its properties were in no way outstanding.

Trialkyl Lead Salts from 'Mixed' Plumbanes

Our work indicated that derivatives of mixed plumbanes possessed rather more pronounced sternutatory properties than did the simple plumbanes. By the reactions outlined in the following scheme, derivatives of diethyl di-n-propyl lead have been made[11,12]. It appeared that a strong acid eliminated one propyl group, whereas a weak acid eliminated one ethyl group.



From ethyl di-n-propyl lead chloride (IV), the corresponding ethyl di-n-propyl lead p-toluene sulphonamide was prepared. By the second type of reaction diethyl n-propyl lead propionate and monochloroacetate were prepared.

Aromatic Compounds

Finally, it may be noted that triphenyl lead chloride, triphenyl lead bromide and triphenyl lead iodide were found to be devoid of sternutatory properties[9] at the concentrations employed in our experiments, that is, at concentrations of the order of 1 in 10^6.

Analysis

The preparation of many hundreds of lead organo-lead compounds necessitated the use of a rapid and reliable method of estimating the percentage of lead in such compounds, particularly as carbon and hydrogen analyses were often incorrect. In outline, the method which we employed[3] consisted in digesting the organic compound in concentrated nitric acid, adding ammonia, and then acetic acid. The lead was then precipitated as lead chromate, which was dissolved in dilute hydrochloric acid, and titrated with ferrous ammonium sulphate solution, using ferrous phenanthroline as internal indicator.

Other Organo-metallic Compounds

In addition to the preparation and examination of the lead compounds mentioned above, we also examined organic compounds containing tin, bismuth, thallium and mercury with the view of obtaining a compound having powerful sternutatory properties[9]. It should be emphasized that these metals were in short supply at the time, and only a compound of outstanding potency would have been of any value.

Briefly, the results were as follows. In general, alkyl-tin salts were found to be only feeble sternutators. Triphenyl tin iodide, $(C_6H_5)_3SnI$, however, was found to have sternutatory properties and to be intolerable at a concentration of 1 in 10^6. This was rather unexpected in view of the fact that the corresponding compound in the lead series, namely, triphenyl lead iodide, is devoid of sternutatory properties. This led us to prepare the following triphenyl tin compounds[9,10], none of which had previously been described:

$(C_6H_5)_3SnCH_2COOEt$, $C_6H_5SO_2NHSn(C_6H_5)_3$, and $(C_6H_5)_3Sn.O.COCH_2COEt$.

As sternutators they were useless.

In April 1941 we prepared diphenyl bismuth propionate, bromoacetate, and iodoacetate[11,12]. These were barely tolerable at a concentration of 1 in $2{\cdot}5 \times 10^7$, and unpleasant after-effects were produced. These compounds, however, were difficult to recrystallize. Diphenyl bismuth chloride, bromide and cyanide were prepared according to known methods, and on testing in the chamber proved to be very good sternutators[11,12], and were probably slightly more powerful than *D.A.* (diphenyl chloroarsine).

Also in 1941 we prepared diethyl thallium bromide, diethyl thallium iodide, diethyl thallium acetate and diphenyl thallium acetate according to known methods. Chamber experiments revealed that they were undetected by human observers at concentrations of 1 part in 10^7.

Similarly, the following mercury compounds were devoid of sternutatory properties, but produced a garlic-like odour at a concentration of 1 part in 10^7:

methyl mercuric iodide, methyl mercuric hydroxide, *n*-propyl mercuric chloride and phenyl mercuric iodide.

Summary

A large number of organo-lead compounds have been prepared and tested as potential sternutators at Cambridge. They have been examined at nominal concentrations (for example, 1 in 1,000,000, 1 in 10,000,000 and 1 in 25,000,000) in a 10-cubic metre chamber, the material being dispersed by spraying a solution in alcohol or ether. Four observers (members of the team) entered the chamber for each experiment.

From the results of the experiments, the compounds were placed in various categories with reference to triethyl lead chloride as an arbitrary standard. It has been established in respect of sternutatory power that :

(1) Salts of the trimethyl lead, $(CH_3)_3Pb^+$, series are markedly inferior to those of the triethyl lead, $(C_2H_5)_3Pb^+$, series.

(2) Salts of the tri-*n*-propyl lead series are superior to the corresponding compounds in the triethyl series. In fact, there appears to be a peak of activity in the tri-*n*-propyl series, derivatives of tri-*n*-butyl lead and above exhibiting diminishing activity.

(3) Derivatives of the monovalent ion (for example, $(C_2H_5)_3Pb^+$) are greatly superior to derivatives of the divalent ion (for example, $(C_2H_5)_2Pb^{++}$).

(4) Within a given series, salts of organic acids (for example, the acetate or acrylate) are usually superior to salts of inorganic acids (such as the chloride). The β-chloropropionates and acrylates are particularly potent.

(5) A new series of substituted sulphonamides of the type $RSO_2NR'Pb R''_2$ has been synthesized. These are of particular interest. They are easily prepared and are powerful sternutators. As in other series, the tri-*n*-propyl lead derivatives are the most potent, and tri-*n*-propyl lead methane sulphonamide is only slightly less potent than the best arsenicals.

We are indebted to the Chief Scientist, Ministry of Supply, for permission to publish the above. We are grateful to Mr. Davidson Pratt for the interest that he has shown in the work, and also to the Chemical Defence Research Departments, Ministry of Supply, in London and at Porton.

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D. Faulkner B. A. Kilby F. Wild
R. Heap G. J. Stacey S. J. Woodcock
F. E. Smith

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SOCIAL MEDICINE AND SOCIAL PATHOLOGY

By Dr. IAGO GALDSTON
New York Academy of Medicine

THE centenary celebration of the New York Academy of Medicine was initiated with a dinner-meeting at the Waldorf-Astoria Hotel on March 6, 1947. Twelve hundred fellows and friends of the Academy gathered in the main ballroom of the hotel and, after dinner, listened to the addresses of the president of the Academy, Dr. George Baehr, and of the guest of honour and principal speaker, Prof. John A. Ryle, professor of social medicine in the University of Oxford.

Dr. Baehr, in his presidential discourse, reviewed the history of the Academy and outlined its anticipated developments in the near future. Prof. Ryle, in his address, discussed the meaning and significance of social medicine and social pathology. Prof. Ryle's address was particularly pertinent in the light of the four-year study which has been conducted by the Academy's Committee on Medicine and the Changing Order. The report of this Committee is to be published shortly.

There is a fairly widespread appreciation in the United States that a substantial number of those items in medical care about which there has been so much discussion (labelled here as "socialized medicine") must and will find a solution in the application of the philosophy and techniques advanced under the head of social medicine.

Prof. Ryle drew upon his thirty years of clinical experience in medicine to bring into prominence the deficiencies in the current teaching and practice of remedial medicine. "I have watched," Prof. Ryle said, "disease in the ward being studied more and more thoroughly—if not always more thoughtfully—through the higher power of the microscope; man in disease being investigated by more and more elaborate techniques and, on the whole, more and more mechanically. Man, as a person and a member of a family and of much larger social groups, with his health and sickness intimately bound up with the conditions of his life and work—in the home, the mine, the factory, the shop, the official on the land—and with his economic opportunity, has been inadequately considered in this period by the clinical teacher and hospital research worker.

"The morbid 'material' of the hospital ward consists very largely—if we exclude the emergencies—of end-result conditions for which, as a rule, only a limited amount of relief repays the long stay, the patient investigation and the anxious expectancy of the sick man or woman.

"With etiology—the first essential for prevention—and with prevention itself the majority of physicians and surgeons have curiously little concern. Nor have they at present the opportunity, nor yet the appropriate types of training or assistance, requisite for the study of etiology or prevention. Their material is mainly selected by four factors: the gravity, the difficulty or the rarity of their cases, or their suitability otherwise for admission to a hospital. Some of the most common diseases, the less lethal diseases and the beginnings of disease are even considered as providing 'poor teacher material'. Health and sickness in the population and their possible correla-

tions with significant and measurable social or occupational influences are outside their province."

Prof. Ryle then cited in illustration a number of diseases, including gastric and duodenal ulcers, which it is not likely that we will master "until we study the victims of the disease at first hand and in relation to their work, their total occupational experience, their communities, their food, their habits and anxieties, and their innate predispositions".

These procedures involve the development of the science of 'social pathology' and 'hygiology', for "the study of the ultimate causes of disease—without which the specific factors can never find their opportunity—goes hand in hand with the study of the causes of health, and how much we have still to learn of the meaning and measurement of health".

Prof. Ryle further defined social pathology as "the medicine and pathology of families, groups, societies or larger populations. Just as human pathology is the related science of clinical medicine—so may social pathology be viewed as the related science of social medicine. Social medicine embraces, on the one hand, the whole of the activities of the public health administration and of the remedial and allied social services, and, on the other, the special disciplines necessary for the advancement of knowledge relating to sickness and health in the community".

Prof. Ryle emphasized the pertinence of his plea, quoting Julian Huxley, who has described current events as a "transition now in progress from the age of 'economic man' to the age of 'social man'. Our profession which is so particularly concerned with man and his welfare," said Prof. Ryle, "must assist this transition with all the scientific and humanist wisdom at its command. Hitherto, our science, like our practice, has evolved along individualist lines. Whatever the several countries may do with regard to the modification of their systems of practice and of service, it seems to me that the scientific study of health and disease in man—the most complex of all social animals—must henceforward concern itself to an ever-increasing degree with the interactions and correlations of disease and health with changing social circumstances. Socially, industrially, politically, we are creating a new age. With it, inevitably, we alter the whole character and distribution of diseases and set ourselves new problems for solution in the fields of medical science, practice and administration."

Prof. Ryle's thesis fitted in very appropriately with the general spirit of the centennial celebration of the New York Academy of Medicine and served as a splendid introduction to the 'Institutes' that have been planned as a part of the centenary celebration; notably the Institutes on Social Medicine, Public Health, and Medical Education. He took part in the Institute on Social Medicine during March 19, 20 and 21, the sessions of which were devoted to the discussion of the following topics: The Changing Concepts of the Relation of Medicine to Society; Social Medicine—Its Differentiation From and Relation to Clinical and Preventive Medicine; Epidemiology in Social Medicine; The Place of Nutrition in Social Medicine; Social Psychiatry and Social Medicine; Social Applications of Psychiatry. The Institute ended with a dinner meeting on March 21, at which Lord Horder, consulting physician to St. Bartholomew's Hospital, London, delivered an address on "Social Medicine: The Appeal of the Common Man".

OBITUARIES

Prof. Pierre Janet

PIERRE JANET, who died in Paris on February 24 at the age of eighty-seven, played a notable part in the development of clinical psychology. He took a degree in philosophy in 1882, and some of his best work was done before taking his degree in medicine eleven years later. He held various academic posts before becoming a professor at the Sorbonne, and was for a time in charge of the psychological laboratory attached to the Salpetrière Clinic. It is not easy to trace his personal relationship with Charcot at that period, and their fundamental attitudes were very different. Thus, in his account of the controversy (*c.* 1886) when Bernheim showed that Charcot's phenomena of hysteria and hypnotism were artefacts, "the results of unskilled suggestion and involuntary training", he wrote ("Principles of Psychotherapy", trans., London, 1925; p. 30): "The victory of the animists was not well received, at least in the scientific world. They acknowledged it but deplored it. The doctrine of Charcot that it defeated was clear, definite, and easy to study; it seemed to bring animal magnetism within the limits of physiology, and that looked like scientific progress."

In 1889 Janet wrote "L'Automatisme Psychologique", in which his conception of dissociation of consciousness subsumes under one formula such apparently disparate manifestations as water-divining, mediumism, the bodily symptoms of hysteria, amnesias, fugues and somnambulisms. In view of the persisting popular belief in the dowser's rod it may be noted that, after describing its use in the pursuit of criminals and the finding of buried treasure, he wrote: "Il est probable que, dans quelques campagnes, subsiste encore la croyance aux révélations de la baguette divinatoire". As a description of what may be supposed to happen in the superficial layers of the mind the theory of dissociation is not incompatible with psychoanalysis, which Janet, however, was not able to accept. In "Les Obsessions et la Psychasthénie", written jointly with F. Raymond in 1903, scarcely any of the bizarre symptoms of these conditions escape recognition. Many are described for the first time, and the writers were a generation ahead in many observations, such as the recognition of writers' cramp as a psychogenic disorder. It is a pity that Janet's word 'psychasthenia' has fallen into disuse, for it avoids the metaphysical assumptions involved in the use of such words as 'neurasthenia' or 'neurosis' to denote pathological mental states.

Much of Janet's writing has been translated and published in Britain and in America. Running through all is an emphasis upon the history of psychopathology, which helps in the understanding of some fundamental differences of opinion that still exist. It must be admitted that his work received little recognition from the medical profession in France, for the spirit of the times was not yet in accord with his psychological approach. In the First World War the French were quick to recognize the importance of psychoneuroses in soldiers; but in their plentiful literature on the subject there seems to be no reference to his teachings. In Great Britain, however, the application of his work on amnesia threw light upon these conditions, and in the Second World War the use of pentothal in the revival of war memories was a tribute to his observation that

"ether, chloroform, and ethyl chloride have been used to bring about hypnotic sleep with some interesting results" (*loc. cit.*, p. 134).

Outside the medical world, however, Janet received full recognition, becoming president of the Academie des Sciences Morales et Politiques, while to many Parisians he was affectionately known as 'Papa Janet'. Last autumn, in spite of his years, he travelled to Zurich and delighted a psychological congress with the charm and erudition he showed in an extempore address. His work is now rather overshadowed by the developments of psychoanalysis, but he stands out as the pioneer who, almost single-handed, brought psychology into practical alliance with medicine.

MILLAIS CULPIN

Dr. A. H. Jay

THE tragic death of Dr. A. H. Jay on February 27 at the age of forty removes one of the most colourful characters from the ranks of X-ray workers in Great Britain. At conferences and discussions one could always be sure that Dr. Jay would present a novel aspect of whatever problems were being aired, and he presented it with a vigour that was characteristic of the man. His pronounced north country accent and his use of personal reminiscences gave his lectures a spice and flavour out of the ordinary.

Those who knew him on more intimate occasions knew also that his originality was not reserved for the lecture room; it manifested itself in many different ways, in research and in committee meetings. As a member of the committee of the X-ray Analysis Group of the Institute of Physics, Jay was a staunch advocate of individuality, and strongly opposed those of us who wished to introduce more standardization into X-ray matters; he had designed and built most of his own X-ray equipment, and he did not see why the coming generation of research workers should not do the same. What he did not realize was that so few were possessed of his energy and initiative, his ability to overcome obstacles. As an example, his high-temperature camera might be cited. Jay designed this camera at Manchester and did much useful work with it; yet, after he left, nobody produced any results with it. The reason for this was obvious: there were so many points in it that had to be attended to at once that only Jay could manage to look after them all!

Jay's qualities were particularly well suited to the type of research work he undertook. His work with Bradley on superlattice formation in the iron-aluminium system is accepted as a model of completeness, and has been the basis of much theoretical investigation. It involved a quantity of measurement that would have daunted a lesser man, but work seemed to give Jay an appetite for more. This quality stood him in good stead in his work for industry, which involved the taking of large numbers of X-ray photographs of refractories. The interpretation of these photographs and the analysis of the results obtained from them enabled him to make many important fundamental contributions to the study of these materials, and it is probably true to say that the main importance of these contributions has yet to be seen.

It is sad to think that he has not lived to enjoy the pleasure of seeing his results applied. Britain can ill afford the loss of men of Jay's type in the present sombre conditions.

H. LIPSON

WE regret to announce the following deaths:

Mr. C. W. Hobley, C.M.G., secretary during 1923–36 of the Society for the Preservation of the Fauna of the Empire, on March 31, aged seventy-nine.

Dr. Willard L. Valentine, editor of *Science* since January 1946, formerly professor of psychology in Northwestern University, on April 5, aged forty-two.

Henri Vallée, *Correspondant* for the Section of Rural Economy of the Paris Academy of Sciences, on March 12.

NEWS and VIEWS

Bacteriology and Immunology in the University of London: Prof. E. T. C. Spooner

DR. E. T. C. SPOONER, who has been appointed to the University of London chair of bacteriology and immunology tenable at the London School of Hygiene and Tropical Medicine, went to Epsom College and to Clare College, Cambridge, where he obtained first classes in both parts 1 and 2 of the Natural Sciences Tripos. After the completion of clinical study at St. Bartholomew's Hospital, he was house-physician to the late Sir Walter Langdon-Brown; he was elected to a Commonwealth fellowship and worked for two years with Prof. Hans Zinsser in the Department of Bacteriology of Harvard University. On his return from America he was elected to a fellowship at Clare College, and a University demonstratorship in the Department of Pathology at Cambridge. He was later elected to a University lectureship and took charge of the teaching in bacteriology for both Part 1 and Part 2 of the Natural Sciences Tripos.

On the outbreak of war in 1939, Spooner became a member of a group of workers at St. Bartholomew's Hospital, which had been 'evacuated' to St. Albans, who were engaged in the study and prevention of the spread of streptococcal infection in surgical wards. Afterwards Dr. Spooner was appointed by the Medical Research Council as the bacteriologist member of a group of medical men who were sent to the Middle East to report on the hospitals and laboratories in North Africa, Egypt and Palestine. On his return to England, Dr. Spooner was for a time in charge of the E.P.H.L.S. laboratory at Cambridge. At the end of the War, Dr. Spooner resumed his work as a University lecturer; in 1944 he was appointed senior tutor of Clare College. Dr. Spooner has published work on the spread of infective disease, especially streptococcal infection, and for his work in this field was awarded the Horton Smith Prize at Cambridge. His chief interest is in the filterable viruses and in virus-produced disease.

Awards of the Valdemar Poulsen Gold Medal

THE Valdemar Poulsen Gold Medal was instituted by the Academy of Technical Sciences in Copenhagen on the occasion of Valdemar Poulsen's seventieth

birthday on November 23, 1939, and the first award was made on that date to Dr. Poulsen himself. Owing to the War, it was not possible to make further awards until 1946, when medals were awarded to Dr. E. F. W. Alexanderson and to Sir Robert Watson-Watt.

Dr. E. F. W. Alexanderson was awarded a Valdemar Poulsen Gold Medal for outstanding contributions to radio-technics, and particularly for the development of a radio-frequency alternator of high power and other system components important in the early progress of radio communication; Dr. Alexanderson was born in Sweden, but his whole work with radio-technics has been done in the United States, where he is a chief engineer of the General Electric Co. at Schenectady.

Sir Robert Watson-Watt was awarded a Valdemar Poulsen Gold Medal for outstanding contributions to the development of radio and particularly for his leading scientific part in the invention and development of the use of radiolocation.

New Chairmen of Research Boards

THE Lord President of the Council has made the following appointments to chairmanships of research boards of the Department of Scientific and Industrial Research from April 1, 1947: Sir Edward Salisbury, director of the Royal Botanic Gardens, Kew, to be chairman of the Forest Products Research Board in succession to Prof. V. H. Blackman; Engineer Vice-Admiral Sir Harold Brown, recently senior supply officer, Ministry of Supply, formerly engineer-in-chief of the Fleet and, during the War, controller general of munitions production, to be chairman of the Fuel Research Board in succession to Sir Harold Hartley; Sir Stanley Angwin, chairman of Cable and Wireless, Ltd., formerly engineer-in-chief of the General Post Office, to be chairman of the Radio Research Board in succession to Lieut.-Colonel Sir George Lee.

A New Form of Camera

MR. EDWIN H. LAND, president and director of research of the Polaroid Corporation, demonstrated recently before the Optical Society of America a camera which produces a dry positive on paper 60 sec. after releasing the camera shutter. The camera contains a roll of film of conventional type, except that the support is opaque, and the exposure is made in the usual way. The camera also contains a roll of specially prepared paper which is not sensitive to light. The paper support is also opaque, and has attached, at intervals equal to the length of the picture, capsules containing a viscous solution of the processing materials. This solution includes hydroquinone and 'hypo' and is released when the capsule is burst on passage of the film and paper between pressure rollers. This takes place after exposure, and the solution is spread as a thin layer between the film and paper, where the following action is said to take place. The hydroquinone rapidly reduces the silver halide in the film in those regions where light action has taken place, thus immobilizing the silver in these regions. In the unexposed regions the 'hypo' takes the silver halide into solution, and diffusion and reduction take place, with the result that silver is deposited in the prepared surface of the paper, producing an image in silver. Since most silver is deposited in the paper in those regions where the least exposure occurs in the camera, the paper image is a positive. The film and paper are pulled apart when the action is complete, yielding a paper 'print' which has a slightly damp surface. The film-paper sandwich passes out of the camera immediately after passing the pressure rollers. The purpose of the opaque supports is to protect the film from further light action while the 'processing' is taking place. In some variants of the system further prints can be obtained from the 'negative', but in general it appears necessary to rephotograph the original to obtain further copies.

Historia Naturalis

IN September 1944, a small group of biologists met in Rome to consider means of promoting the interests of their science, and by December of the same year their suggestions had received sufficient support to justify the formation of a society of naturalists, Unione Italiana Naturalisti. By 1946, the society was strong enough to issue its own journal. This publication, *Historia Naturalis*, is about the same size as *Nature*, and each part so far published consists of 24 pages, exclusive of the cover. It is illustrated with line and half-tone text figures and is quite well printed. It appears three times a year—in March, June and September—and the issues of the first year are now to hand.

The object of the journal is not merely to record the meetings and activities of the society, which are many—indeed these only occupy a page or two—but to emphasize the fundamental unity of the biological sciences, interpreting these in a wide sense. It appeals not only to the professional specialist but also to the intelligent amateur. The major portion of each issue is therefore devoted to original studies and researches, to reports of conferences and symposia, to reviews and essay reviews covering diverse aspects of natural history. The original contributions have included, among others, general and vertebrate palæontology, geology (tectonics), evolutionary problems, animal populations and experiments on Coleoptera. We should like to congratulate our colleagues on their courage in making a start in this field when general conditions were far from encouraging, and welcome the new journal, which undoubtedly fills a need. If the publication fulfils the promise of its first year—and there is no apparent reason why it should not—it is assured of a permanent place in scientific literature. The annual subscription to *Historia Naturalis* is 150 lire, to be sent to Domenico Rossi, via Tomacelli, 132, Rome.

Engineering Degree Courses for Ex-Servicemen

MANY who were studying engineering before being called up for national service have been unable to complete degree courses, and although they have become competent engineers, their future career would benefit greatly if they were able to obtain a degree. Mr. O. S. Puckle, of R.F. Equipment Ltd., Langley Park, near Slough, Bucks, believes that suitable courses of study at a number of technical colleges throughout Great Britain, either in the form of a full day on Saturday or a half-day on Saturday and, say, one, or at most two, evenings per week, could be devised to meet this need. He therefore invites engineers or physicists who are interested in such a proposal to communicate with him. Should the number of replies prove to be sufficient, he proposes to communicate with the Ministry of Education in order to ascertain whether something can be done to meet the situation. He has in mind two types of course, covering two or three years and leading to final B.Sc. or B.Sc.(Eng.), depending on whether the intermediate examination has been

passed. Replies, stating the nearest technical college which could be attended, should be sent to Mr. Puckle as early as possible.

World Power Conference on Fuel Economy

A PRELIMINARY programme has been issued of a sectional meeting of the World Power Conference to be held at The Hague during September 2–9, 1947, when the subject of discussion will be "Fuel Economy". The proceedings will be divided into three sections dealing with production, distribution and utilization respectively. Copies of national reports on fuel economy prepared at the request of the central office of the World Power Conference and also of all printed papers prepared for the meeting will be supplied to members of the Conference; all sessions will be devoted to oral discussion. Papers can only be submitted through national committees; the address of the British National Committee is 201–2 Grand Buildings, Trafalgar Square, London, W.C.2, to which intending members resident in Great Britain should apply for particulars. The address of the secretariat for the meeting is Vereeniging voor Congressen op Electrotechnisch en Aanverwant Gebied, 210 Utrechtscheweg, Arnhem, Netherlands.

X-Ray Analysis Conference

The 1947 Conference of the X-Ray Analysis Group of the Institute of Physics will be held at the Royal Institution, Albemarle Street, London, during April 22–23. The first day will be devoted to discussion of the training of X-ray crystallographers for science and for industry; the second will be devoted to new techniques and results. Mr. H. P. Rooksby, of the Research Laboratories, General Electric Co. Ltd., Wembley, will give an evening lecture on the technique of X-ray powder photography on April 22. Short papers only are being given, so as to leave time for informal discussions. The Conference is open to all interested in the subject. Further particulars can be obtained from the honorary secretary of the Group, Dr. F. A. Bannister, British Museum (Natural History), London, S.W.7.

Conference on Applications of Radioactive Tracer Elements

A CONFERENCE is being arranged by the Manchester and District Branch of the Institute of Physics on "Applications of Radioactive Tracer Elements in Physics Research and Industry" during July 10–12 in the Physics Department of the University of Manchester. The opening papers will be given by Dr. J. D. Cockcroft, Prof. F. Paneth and Mr. D. H. Wilkinson. The conference will be open to anyone interested, without charge, but admission will be by ticket only. Further particulars will be issued in due course by the Conference Secretary, W. J. Meredith, Christie Hospital and Holt Radium Institute, Wilmslow Road, Manchester 20.

University of Durham: Appointments

THE following appointments have been made in the University of Durham: Martin Jones, to be professor of agricultural botany at King's College, Newcastle; Ewen M'Ewen, to be professor of engineering in the Faculty of Agriculture at King's College, Newcastle; Alexander Kennedy, to be professor of psychological medicine at King's College, Newcastle; Leonard Slater, to be reader in geography in the Durham Colleges.

Arthur Stanley Eddington Memorial Lectureship

LAST year an appeal was launched to provide for the founding of an Arthur Stanley Eddington Memorial Lectureship to commemorate Eddington's life and work, by providing for lectures on some aspect of contemporary scientific thought considered in its bearing on the philosophy of religion, or on ethics, and to be delivered periodically in Cambridge, or elsewhere, and to be published. The Foundation Trust Deed has now been completed, and the following four trustees have been appointed: Prof. Sydney Chapman, representing the Royal Society; Prof. C. D. Broad, representing Trinity College, Cambridge; Dr. Kathleen Lonsdale and Dr. W. H. Thorpe, representing the Society of Friends. Mr. Howard Diamond, 45 St. Barnabas Road, Cambridge, is honorary treasurer and secretary of the trustees. The Fund is still open, and approximately £1,000 is now needed for its completion. It is hoped that the first lecture on the Foundation will take place towards the end of the present year.

The Boron-Trifluoride Catalysed Reaction of Di-isobutene

Dr. Alwyn G. Evans and M. A. Weinberger write: "In our recent communication on this subject [*Nature*, March 29, p. 437], it is stated that the addition of acetone vapour, purified by distillation *in vacuo* over freshly distilled sodium, to a non-reacting mixture of di-isobutene vapour and boron trifluoride initiates the fast reaction of di-isobutene. In our corrected proof of this letter [received too late for changes to be made. Editors] we deleted this statement on the grounds that since traces of water are so effective in initiating this reaction, we do not as yet wish to claim that completely pure acetone itself is effective in this way."

Announcements

THE James Watt International Medal for 1947 of the Institution of Mechanical Engineers will be presented to Prof. S. Timoshenko, recently professor of engineering at Stanford University, California, on April 25; he will speak on "Stress Concentration and Fatigue Failures".

MR. F. BRUNDRETT, of the Royal Naval Scientific Service, has been appointed chief of the Service in succession to Sir Charles Wright, who retires on April 30.

BY arrangement between the University of Sheffield and the Council of the Iron and Steel Institute, the second Hatfield Memorial Lecture will be given by Dr. C. Sykes, of the Brown–Firth Research Laboratories, Sheffield, in the Institution of Civil Engineers, London, on May 14 at 8.30 p.m., on the occasion of the annual general meeting of the Iron and Steel Institute, and will be entitled "Steels for Use at Elevated Temperatures".

DR. DOUGLAS GUTHRIE is delivering a course of lectures in the University of Edinburgh on the history of medicine, beginning on April 17. As part of the course, guest lectures will be given by Sir Arthur MacNalty on the evolution of preventive medicine in Britain on May 16, and by Sir Henry Bashford on Hans Sloane on May 23.

ERRATUM. In the communication "Spiral Cracks in Glass Tubes" by Dr. L. Norzi, published in *Nature* of March 1, p. 306, paragraph 5, line 2, for "$tg2\varphi = 2C/|(B - A)|$" read "$tg2\varphi = 2C/|(B - A)|$".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Plasma Cellular Reaction and its Relation to the Formation of Antibodies *in vitro*

DURING secondary response, elicited in sensitized rabbits by means of intravenous injections of the homologous antigen, the number of plasma cells in the spleen increased considerably, simultaneously with the formation of antibodies[1]. The cellular reaction was localized almost exclusively to the red pulp, especially after the injection of living *Salmonella typhi* (about 500 millions/kgm.). The spleen was investigated by means of biopsies at intervals during antibody formation; differential counts of imprints were made and histological sections were examined. The stain used was methyl green pyronine (Unna–Pappenheim). In the earliest stages of the reaction, in the first phase of antibody formation, large reticulum cells of characteristic appearance (called transitional cells) presented themselves. One or two days later, immature plasma cells appeared at the places where transitional cells were previously found, and after a further few days mature plasma cells were seen in increasing numbers. There were numerous transitions between the different stages of development. No plasma cells were usually seen in the lymph follicles.

Antibody formation in vitro. Small pieces of spleen tissue, partly from the red pulp, partly from the lymph follicles, were excised in different phases of antibody formation, and their capacity for forming antibodies *in vitro* was investigated. In each tube, containing 300 mgm. of fluid, one or two pieces were cultured. Their weight (wet) was about 0·2 mgm. The culture fluid consisted of normal rabbit serum (3 parts), tyrode solution (2 parts) and isotonic sodium bicarbonate (1 part). A gas mixture, consisting of 80 per cent oxygen, 4·5 per cent carbon dioxide and the remainder nitrogen, was passed into the tubes[2]. The tubes were incubated at 37° for 5–12 hours. The capacity for antibody formation *in vitro* of the red pulp rich in plasma cells proved to be considerably superior to that of the lymph follicles (see Table 1). By serial investigations on the same animal, it was found that the tissue pieces were most active in forming antibodies when the immature plasma cells predominated. The transition from immature to mature cell coincided with a decline in the capacity to form antibodies *in vitro*. Pieces of the same size were excised from other organs rich in R.E.S. Their capacity for antibody formation *in vitro* was investigated and proved to be very much inferior to that of the red pulp of the spleen (see Table 2). Experiments were also made to trace the antigen (living *Salm. typhi*) after intravenous injection. The greatest number of bacteria was found in spleen and liver, less in bone-marrow, and very few bacteria could be demonstrated in lymph glands and thymus. In the spleen the bacteria were found in large numbers in the red pulp, and only small numbers in the follicles.

TABLE 1. COMPARISON BETWEEN THE CAPACITY OF THE RED AND THE WHITE PULP TO FORM ANTIBODIES *in vitro*. THE SPLENIC TISSUE EXAMINED AT DIFFERENT STAGES OF ANTIBODY FORMATION IN THE RABBIT

No.	Days after re-inject.	Serum titre		Duration of culture (hr.)	No. of plasma cells in each tube (1 cell about 0·2 mgm.)	No. of tubes containing 300 mgm. cult. fluid		Geom. mean of titres *in vitro*	
		Day of culture	Preceding day			Red pulp	Lymph follicles	Red pulp	Lymph follicles
S 167	4	1/10,240	1/1,280	12	1	12	12	1/12	0
	7	1/40,960	1/40,960	12	1	12	12	1/3·6	0
S 173	4	1/10,240	1/1,280	12	1	6	7	1/4·8	1/0·3
	7	1/81,920	1/81,920	12	1	7	7	1/3·6	1/0·4
S 186	4	1/5,120	1/640	8	1	10	10	1/4·6	1/0·3
				12	1	13	8	1/8·6	1/0·4
	10	81,920	81,920	12	1	6	6	1/2·8	0
S 175	4	1/640	1/160	8	1	10	10	1/3·7	1/0·8
				12	1	10	10	1/7·5	1/1·6
	8	1/10,240	1/10,240	12	1	11	10	1/0·5	1/0·1
S 190	4	1/1,280	1/80	5½	1	20	10	1/3·3	1/0·4
					2	10	8	1/5·5	1/1·3
S 203	5	1/20,480	1/2,560	8	1	27	20	1/19·7	1/1·4

TABLE 2. THE ANTIBODY FORMATION CAPACITY *in vitro* OF VARIOUS ORGANS RICH IN R.E.S.

No.	Duration of culture	Tissue in each tube (mgm.)	Geom. mean of titres of culture fluids				
			Splenic red pulp	Lymph gland	Thymus	Bone marrow	Liver
S 182	12 hours	0·4	1/30·0	0	0	0	0
No. of tubes			10	10	5	10	10
				L. axill. 1/2·7*			
S 206	5 hours	0·8	1/72·7	L. popl. 0	0	1/1·0	1/1·0
No. of tubes			12	6 each	12	12	12

* Lymph. gland. axill., regional to the subcutaneous agar focus containing antigen, through which the rabbit was sensitized.

It is concluded that plasma cells appear in connexion with great antigen stimulation. The antigen incites a conversion and an intensification of the protein production in the reticulo-endothelial cell. From the functional point of view, development culminates in the formation of the immature plasma cell. The further differentiation of the cell, when mature plasma cells appear, marks the transition to a less active state, and the mature plasma cell then becomes the final link in a chain of development, a cell which has already passed its greatest functional activity.

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Phenyl-thio-carbonyl Chloride as a Group-protecting Agent

THE use of the carbobenzoxy reagent for protection of amino-groups in the course of peptide synthesis has, in spite of its obvious advantages, some limitations. In some cases, hydrogenolysis of the benzyl group is complicated by simultaneous hydrogenation of other groups present, and also carbobenzoxy compounds are sometimes difficult to crystallize; for example, *N*-carbobenzoxy-glycyl-cysteine ethyl ester. The use of another protecting unit easily removed by hydrolysis in combination with the carbobenzoxy method would considerably extend the use of the latter.

Phenyl-thio-carbonyl chloride, $C_6H_5S{-}COCl$, as prepared by Rivier[1], would appear to be of use in this respect. The corresponding amide and phenylamide were reported by Rivier to be stable in dilute acids and easily hydrolysed by alkalis. The extension of the method to other amides and to the amino-acid series has now been developed. Direct Schotten–Baumann acylation in aqueous alkali solution was not very successful, but the reaction of one mole of phenyl-thio-carbonyl chloride with 2 moles of amino-acid ester in ether or ethyl acetate proceeds easily at room temperature, one mole of amino-acid ester hydrochloride being liberated. After washing with dilute hydrochloric acid, the phenyl-thio-carbonyl amino-acid esters are easily isolated. Among the compounds prepared are phenyl-thio-carbonyl-glycine ethyl ester, m.p. 104°, and bis-(phenyl-thio-carbonyl)-cystine dimethyl ester, m.p. 108°.

The acylamino-acid esters thus prepared are easily de-esterified by heating for ten minutes in a mixture of concentrated hydrochloric acid and glacial acetic acid (1 : 1), the phenyl-thio-carbonyl group being remarkably stable in acids. The free acylamino-acids separate on dilution with 2 moles of water (for example, phenyl-thio-carbonyl-glycine, m.p. 155°), and can be converted to the corresponding chlorides by the action of phosphorus pentachloride in ether. The chlorides (for example, phenyl-thio-carbonyl-glycine chloride, m.p. 87°) crystallize readily and are rather stable. They react in ether or chloroform solution with free amino-acid esters to form peptide esters: phenyl-thio-carbonyl-glycine-glycine ethyl ester, m.p. 127°, phenyl-thio-carbonyl-glycine-*dl*-alanine methyl ester, m.p. 116°, phenyl-thio-carbonyl-glycine cysteine ethyl ester, m.p. 114°. The latter crystallizes readily, unlike the corresponding carbobenzoxy compound. In general, the melting points of the phenyl-thio-carbonyl derivatives lie about 50° above those of the carbobenzoxy compound.

The removal of the phenyl-thio-carbonyl-group is easily carried out by heating for five minutes with a solution of lead acetate in 70 per cent ethanol or by treating in the cold with 0·1 *N* alkali in the presence of lead hydroxide or lead carbonate, yellow lead phenylmercaptide being precipitated. In alkali, phenyl-thio-carbonyl-amino-acids are decomposed in 10–30 sec., the corresponding esters reacting similarly in 5–10 min.

This observation, together with the fact that PhS—CO—O— and PhS—CO—S compounds could be similarly prepared and split, provides a basis for an extension of peptide synthesis. Compounds of the type PhS—CO—O*R* can be prepared by heating the appropriate alcohol with phenyl-thio-carbonyl chloride either alone or with alkali (10 per cent). The alcohol can also be employed in the form of alkoxide. Phenols and SH-compounds react in the same way. The use of phenyl-thio-carbonyl chloride is capable of a number of variations and should find useful applications in other fields.

Full details of this work in connexion with peptide synthesis will be published elsewhere.

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[1] Rivier, *Bull. Soc. Chim.*, (4), **1**, 733 (1907).

Use of Seeds in the Insect Transmission of Some Plant Viruses

THE methods previously adopted for the insect transmission of the viruses causing swollen-shoot disease of cacao (*Theobroma cacao* L.) employed seedlings usually between six and twelve months old. An improved technique utilizes the seed as a test plant and a watch-glass or specimen tube as a cage, a method which might be applicable to experiments with viruses of other plants with exalbuminous seeds.

The cacao bean is taken from the ripe pod, the testa removed, and one cotyledon dissected away to expose the convoluted surface of the other. Insects which have fed on an infected plant for the required time are transferred with a brush to the bean, placed in a solid or 'block' watch-glass. Humidity can be maintained by a square of damp filter paper under the cover of the watch-glass, and after the desired feeding time, the insects are killed with nicotine solution. The beans are then planted in sterilized sand in an insect-proof house. Germination is not affected, and symptoms usually appear in the first or second pair of foliage leaves, occasionally in the third. The vectors used successfully in these experiments are the mealy-bugs, *Pseudococcus citri* Risso, *Ps. njalensis* Laing, and *Ferrisia virgata* Ckll., which feed readily on the beans not only of cacao but also of *Cola* spp., and of *Phaseolus vulgaris*.

The use of beans in small containers has numerous advantages over that of larger plants in pots. The movement of the vectors is controlled, and feeding periods can be observed conveniently with a microscope. Complete exclusion of other insects is ensured without the necessity for cages, and a large number of test plants can be accommodated in a small space in the laboratory. Unless the virus under investigation is seed-transmitted, when care would be taken to ensure an uninfected source of seed, any chance of prior infection of the test plants is eliminated, together with the difficulty of maintaining a constant source of virus-free plants of the correct size and condition for vector experiments. Not the least important advantage of the method as applied to cacao is a shortening of the mean period between the time of infection and of the development of symptoms, and a reduction in its variation between plants. In experiments using large plants, the interval between inoculation and the appearance of symptoms depends on the periodicity of growth-flushes, which differs greatly with season and also between plants, resulting in latent periods varying between three weeks and four months. When seed is used, symptoms are usually visible in the leaves about three weeks after the beans were infested.

The method can be modified for testing suspected vectors found in natural outbreaks of virus diseases far distant from the laboratory. Peeled cacao beans

are planted in damp sterilized sand in specimen tubes of suitable size, with the mouth sealed with muslin held by a rubber band. Germination commences at once, and a seedling can be kept in each tube for about two weeks prior to transplanting. Suspected vectors found on infected plants are transferred to the cotyledons and allowed to feed until the return to the laboratory, where they are removed and the seedling planted. In this way virus transmissions were carried out in outbreaks of swollen-shoot disease in the Ivory Coast, and the infected plants established in the Gold Coast after a tour of 1,400 miles lasting seventeen days.

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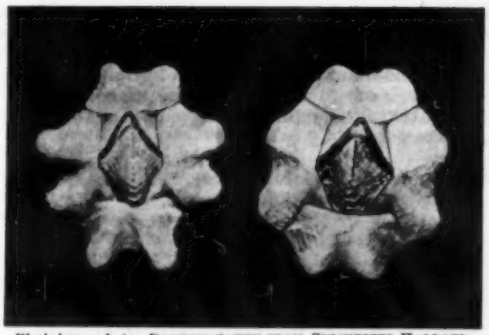
Establishment of an Immigrant Barnacle in British Coastal Waters

As part of the programme of anti-fouling investigations being carried out by the Marine Corrosion Sub-Committee of the British Iron and Steel Research Association, data have been collected on the nature of fouling organisms and their seasonal variations of settlement and growth at a number of stations around the British coasts. A full account of this work and of work on the fouling of ship bottoms will be published at a later date, but it seems desirable to record the establishment in British waters of an austral barnacle, which appears to have arrived as a component of ship-fouling.

The examination of small, unpainted 'Bakelite' panels immersed for successive monthly periods at constant depths of 2 ft. and 4 ft. from the Admiralty Raft inside the mouth of Chichester Harbour, West Sussex, has shown that heavy settlements of acorn barnacles characterize the fouling settling at this site from mid-March to the end of October. These barnacles have been identified as *Elminius modestus* Darwin, a common estuarine barnacle in southern Australia and New Zealand, and *Balanus improvisus* Darwin, a common estuarine form in British and northern temperate waters. The settlement density and relative numbers of the two species have varied from month to month, but in general the former species has been the more abundant. In July 1945 the average numbers were two hundred *E. modestus* and two *B. improvisus* per square inch of surface area. The alien species has grown well (attaining a carino-rostral diameter of 6 mm. in 40 days during June and July), but less rapidly than *B. improvisus*, which furthermore appears to be a larger species when fully grown.

Darwin[1] gives the distribution of the genus *Elminius* as "southern temperate seas", and of the species *E. modestus* as "New South Wales, Van Diemen's Land, New Zealand"; and Gruvel's brief reference[2] to a new species, *E. cristallinus*, from the Azores appears to be the only published report of the occurrence of the genus in the northern hemisphere. Moore[3], in a recent account of *E. modestus*, describes it as a common estuarine, inter- and sub-tidal form in New Zealand, averaging 5 mm. in diameter, breeding throughout the year and occurring as fouling on harbour vessels and test panels. This species in its native waters appears to occupy the position held by *B. improvisus* in the British fauna. Its appearance is superficially not unlike that of the common British shore barnacles, but a close examination shows that the compartments are reduced to four in number (see photograph) in contrast to six present in the genus *Balanus*.



Elminius modestus DARWIN, TAKEN FROM CHICHESTER HARBOUR, SHOWING THE ARRANGEMENT OF THE FOUR COMPARTMENTS. NATURAL SIZE, 6 MM. CARINO-ROSTRAL DIAMETER

I have been unable to examine the shore of Chichester Harbour for the alien species, but the foregoing data clearly show that *E. modestus* is well established at this site. Two further records of the species, in both cases associated with *B. improvisus*, suggest that this immigrant is also present in other localities on the coast. The species was taken from the hull of the S.S. *Queen Elizabeth* (August 1946) after a long stay at Southampton subsequent to North Atlantic service, and from the hull of the M.V. *Empire Wansbeck* (October 1946), which had been plying between Harwich and the Hook of Holland.

Observations on ship-fouling show that a variety of foreign marine organisms, often fully grown and living, are continually being brought into British waters on ship hulls, and that many of these species are able to survive for long periods while the vessels are in British ports. There is little evidence, however, that alien species have been introduced to the coasts of Great Britain in this way, and probably the low water temperature prevents breeding in most of these species (Orton[4]), a consideration which would not apply to warmer seas. It is of interest to note in this connexion that in 1937 Mr. D. Dilwyn John (personal communication) collected a species of foreign barnacle, probably a variety of *B. amphitrite*, from buoys in the Shoreham Harbour Canal, the water of which was heated to approximately 10° F. higher than the outside channel water (in November of that year) by large discharges of hot sea water.

It seems likely that *E. modestus* has been carried from its native coasts to the south coast of Britain as fouling on a ship, and being a temperate water species, has been able to establish itself. This theory is supported by the occurrence in October 1946 of this species on the hull of the M.V. *Waipawa* at Liverpool, after service in southern Australia and New Zealand. These specimens of *E. modestus*, associated with *B. amphitrite* Darwin and *B. trigonus* Darwin, were living, in good condition, and fully grown (9 mm. carino-rostral diameter), but the gonads were in a very early stage of development. All three species had successfully survived a fast passage at 17 knots for 30 days, via the freshwater lakes of the Panama Canal.

I am grateful to Dr. J. P. Harding, British Museum (Natural History), for confirming the identity of

E. modestus, to Dr. H. G. Stubbings (Admiralty) for supervising the exposure of panels in Chichester Harbour, to the Cunard White Star Line, Ellerman's Wilson Line and Shaw Savill and Albion Line for their assistance, and the Marine Corrosion Sub-Committee for permission to publish this communication.

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British Folliculinidæ (Ciliata, Heterotricha)

While examining plates submerged in sea water at Cullercoats, I have come across two species of Folliculinidæ which, to my knowledge, have not been reported so far from Great Britain. They are *Folliculinopsis* (*Folliculina*) *producta* Wright and *Folliculina simplex* Dons. The *Folliculinopsis producta* forms are remarkable for their large size and extreme elongation of the body, the overall length of my specimens ranging from 2,000 μ to 2,600 μ (2·0–2·6 mm.); and a few specimens were as long as 3 mm., a large size indeed for a simple non-colonial protozoon. The biology of these two species has been worked out and is being published elsewhere.

Sixteen well-marked species of Folliculinids are known from the Continent[1,2] and ten species from the United States[3], while only three species have been recorded from Great Britain so far[4,5,6], namely, *Folliculina ampulla* Müller (Plymouth and Port Erin), *Folliculina elegans* Clap. and Lach. (Port Erin), and *Parafolliculina hirundo* Kent (Channel Islands). The present two species from Cullercoats bring the number of British Folliculinidæ to five.

My thanks are due to Prof. A. D. Hobson for helpful suggestions and to Dr. H. O. Bull for assistance in identification.

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Feb. 18.

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[2] Kahl, "Tierwelt der Nord- und Ostsee", **23** (2), 93 (1933).
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[4] Kent, "A Manual of Infusoria", **2**, 599 (1880–82).
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Entamœba sp. from the Syrian Hamster (*Cricetus auratus*)

During the course of work on experimental infections of *Entamœba histolytica* in rats, it was noticed that rats sometimes developed spontaneous infections with an amœba showing characters differing from those of *E. histolytica*. An examination of hamsters, which were housed in the same room, revealed the presence of a similar amœba. Hitherto there has been no report of an amœba parasitic in the hamster.

All observations were made on fresh material, and also on fixed and stained smears made from hamsters used for tests of leishmanicidal drugs.

Amœbic infection was found in fifty hamsters (59 per cent) of eighty-five examined; of these, thirty-seven harboured only the trophic amœbæ, while thirteen also had cysts. Pseudopodia consisted of ectoplasm, clearly demarcated from the endoplasm, and in stained specimens presented a homogeneous structure. In a fresh smear the rounded forms had a diameter of 17–28 μ. The spherical nucleus varied in size between 3·50 and 5·75 μ; it contained a compact, rather irregularly shaped karyosome which occupied a very eccentric position, being frequently situated near the nuclear membrane. The peripheral chromatin consisted of a layer of fine granules more or less in contact with one another. The endoplasm was vacuolated; food vacuoles contained bacteria, plant debris, and other Protozoa, chiefly trichomonads. *Sphærita* was also present in some cases.

The ripe cysts contained eight nuclei, the karyosomes of which were usually strongly eccentric. Chromatoid bodies, not commonly present, were elongated with irregular ends. The cysts ranged in size from 12·5 to 22 μ in diameter, with an average size of 17 μ. No evidence of races of larger or smaller dimensions has yet been obtained.

Experiments were performed to determine whether the amœbæ from the hamster were infective to rats. Suspensions of cæcal contents of infected hamsters were administered orally to young rats each receiving 0·25 ml., containing eighteen cysts. The rats were isolated in cages, special precautions being taken to prevent accidental contamination, and the cæca examined after ten days. Nine of eleven inoculated animals developed amœbic infections, while normal control animals kept under identical conditions all remained free from infection.

The amœbæ from the hamster thus proved to be infective to rats. The morphology of the trophic amœbæ and cysts was unaltered in the second host. The amœbæ were found to survive for a time in Dobell and Laidlaw's horse-serum and Ringer egg medium[1], but did not multiply and died after twenty-four hours.

The amœba was apparently non-pathogenic, although two of the experimentally infected rats showed slight diarrhœa. From these observations it would seem that the rats might acquire their infection from hamsters kept in the laboratory.

Fuller details of this investigation will be published elsewhere.

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[1] Dobell, C., and Laidlaw, P. P., *Parasit.*, **18**, 283 (1926).

Isotropy in the *J* Striation of Striated Muscle

Frey-Wyssling[1], following Hürthle, explains the isotropy of the *J* striation in muscle as the crossing of micellar structure. C. E. Hall, M. A. Jakus and F. O. Schmitt[2] established by electron micrographs that myofibrils are composed of parallel bundles of filaments lying axial with the fibrils both in the *Q* and *J* striations. On the basis of their experiments these authors put forward two hypotheses to explain

the isotropy: it is caused either by differences in orientation within the filaments in the *J* striation, or by a component which compensates the positive birefringence of the filaments.

We have carried out investigations on rat muscle. Muscle pieces 1 cm. long and of 2–3 mm. diameter were treated for 20 minutes at 0° with a solution containing 0·6 mol. potassium chloride + 0·04 mol. sodium bicarbonate + 0·01 mol. sodium carbonate + 1·0 per mol. adenosintriphosphate. After this they were treated for another 20 min. with 0·6 mol. potassium iodide solution. In this way the contractile substances (myosin and actin) were extracted[2,4]. Then the pieces of muscle were put into solutions of potassium iodide of successively decreasing concentrations until, by swelling, the muscle pieces regained their original size.

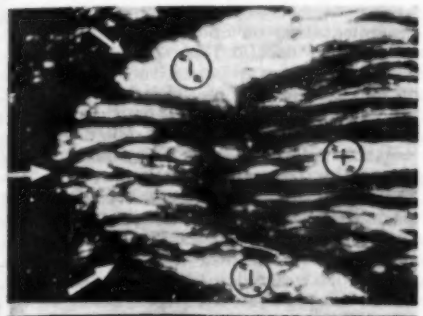

Fig. 1

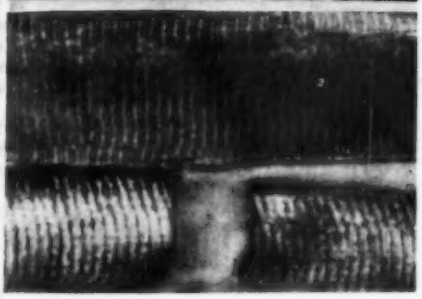

Fig. 2

Fig. 1. A BUNDLE OF MUSCLE FIBRES TREATED WITH WEBER'S SOLUTION AND WITH 0·6 MOL. POTASSIUM IODIDE. THE ARROWS SHOW THE DIRECTION OF PENETRATING SOLUTIONS. PHOTOGRAPHED IN POLARIZED LIGHT USING A GYPSUM PLATE (RED I.) AT + 45°. THE FIBRES MARKED "+" ARE INTACT SHOWING POSITIVE DOUBLE REFRACTION; THE MARGINAL FIBRES MARKED "|" HAVE A NEGATIVE DOUBLE REFRACTION

Fig. 2. (*a*) AN UNTREATED MUSCLE FIBRE IN POLARIZED LIGHT USING GYPSUM PLATE (RED I.) AT + 45°. THE *Q* STRIATION AND THE *Z* LINE ARE BLUE (LIGHT IN PHOTOGRAPH); THE *J* STRIATION IS DARK

(*b*) A MUSCLE FIBRE TREATED WITH WEBER'S SOLUTION + POTASSIUM IODIDE (SIMILAR ADJUSTMENT). THE *J* STRIATION IS YELLOW-COLOURED (LIGHT IN PHOTOGRAPH); *Q* STRIATION AND *Z* LINE ARE DARK

The treated muscle pieces were fixed in 10 per cent formaldehyde and embedded in paraffin. We cut the sections at 10 μ and analysed them by a polarized-light microscope, using a gypsum plate (Red I. + 45°). It was found that the areas penetrated by the solution became negatively birefringent (Fig. 1). With greater enlargement it was noticed that the negative birefringence appears in the *J* striation, and that positive birefringence disappears, so that the *Q* striation becomes dark (Fig. 2). Quantitative measurements gave the negative birefringence of the treated fibres as $n_\gamma - n_\alpha = -39 \times 10^{-4}$, of the untreated fibres as $n_\gamma - n_\alpha = +40 \times 10^{-4}$.

The negative birefringent material was called *N*-material. It is extractable from the *J* striation with Weber's solution containing 30 per cent urea. The extracted substance showed a strong double refraction of flow. In our control experiments it was established that the *N*-material is originally in the isotropic striation and is not a product of the action of potassium iodide on muscle proteins. It is evident that the *N*-material locally compensates the positive birefringence of the contractile-proteins and is the cause of isotropy.

We found the *N*-material to be identical with the negative doubly refracting and phosphorus-containing structure-protein isolated by I. Banga and A. Szent-Györgyi[5]. It is probably the substance seen in the electron micrographs of muscle fibril made by Hall, Jakus and Schmitt and marked "N stripe".

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Tumour Inhibition with Extracts of Urine

FROM time to time, various investigators have reported upon growth-inhibiting and growth-stimulating properties of extracts of urine[1]. The investigations outlined below are being conducted in relation to the extract known as H.11, and it is with the former of these that we are concerned, although we have noted the presence of the latter.

In our experimental investigations, which are directed towards the isolation of compounds with tumour-inhibiting properties, as a preliminary means of recording whether or not an extract is active—and by this is meant its ability or otherwise to produce inhibition or, more desirably, complete permanent regression of tumour growth, without causing measurable toxic condition in the animal under treatment—we have used the Twort alveolar carcinoma.

From a considerable number of fractions tested for tumour-inhibiting properties, we have found that normal male urine, acidified to *p*H 4 and continuously cold-extracted with toluene, results in a crude extract containing the active agent. A considerable quantity of inactive material, chiefly in the way of pigments, is removed with activated carbon. Absorption of the resulting extract upon activated alumina, and subsequent elution with toluene + 1 per cent ethanol, results in a considerably purified active extract. Of some twenty fractions obtained from the chromatographic analysis, this is the only fraction which has consistently shown the power to inhibit the growth of the Twort alveolar carcinoma. This fraction is partitioned against 60 per cent ethanol, and the active principle is found to be contained in the aqueous alcoholic phase. The dissolved solids contained in this phase are converted into an aqueous colloidal extract, buffered to *p*H 7, and this extract is at present used for bio-assay.

It is impossible at this stage to give any indication as to the possible chemical nature of the active agent contained in the extract at present employed for bio-assay. The extract is subject to oxidation fairly readily; it exhibits neither œstrogenic nor androgenic activity in either bio-assay or by chemical colorimetric determinations. These facts are supported by adsorption spectra data. Aqueous extracts appear to lose activity after about a month's storage in a refrigerator; stability to heat has been established to 100° C. at 20 mm. pressure in the absence of water. Decomposition occurs at about 60° C. when heated at atmospheric pressure in the presence of water.

Hot hydrolysis of urine under the conditions usually employed for the isolation of sex hormones, and subsequent treatment by the method outlined above, results in an inactive material. Attempts at chemical separation, such as benzoylation, acetylation, half succinate division into alcoholic and non-alcoholic material, Girard division into ketonic and non-ketonic fractions, and the orthodox procedures employed for the separation into acids, bases, phenols (strong and weak) and neutral compounds, have failed to give significant biological results.

Bio-assay has been carried out on a large number of mice, and present indications are that response to treatment is maximal in daily doses of 400 γ, as measured in terms of total solids. Toxicity tests have been carried out on all fractions prior to bio-assay. Injections were carried out over a period of ten days, response to treatment usually commencing at about the fourth day. The route employed was by intraperitoneal injection, and it has been noted that tumour size does not materially affect the issue, as an extract capable of inhibiting the growth of small tumours has been found equally capable of inhibiting the growth of tumours of larger area and vice versa.

Of a total number of sixty-eight tumour-bearing mice, 33·6 per cent showed varying degrees of inhibition of tumour growth; 36·8 per cent showed partial regressions of tumours; 23·5 per cent showed complete regressions of tumours, and 7·1 per cent showed no response at all; the number of controls being forty-six, and having 4·4 per cent spontaneous regressions.

The fraction employed at this stage of the research has since been further separated into eight fractions, and these are at present under biological and chemical investigations.

We are indebted to Mr. J. H. Thompson, director of research at these Laboratories, for his constant help and encouragement during the course of these investigations, to Dr. O. Pecznick of the Department of Pathology, for undertaking the bio-assay of the numerous fractions we have produced for examination, and to all other members of the research staff for their continuous interest and helpful discussion.

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A Possible Explanation of the Relations between Hereditary Anæmias and Depigmentation in the Mouse

In mice there are two chief forms of hereditary anæmias, the macrocytic and the siderocytic or flexed tail anæmia[1]. The former is due to one of the dominants *W* or *W*^{v}, the first of which is lethal when homozygous while the second is viable. *WW* and *W*^{v}*W*^{v} animals are white with black eyes, and in the heterozygotes with the normal *w* the two factors may or may not show dominance, according to the factor concerned and the genetic background[2]. The other form of anæmia, the siderocytic, is due to the recessive factor *f* and is also associated with depigmentation. All the *ff* animals show a transitory anæmia at birth, and the majority of them have also a white spot on the belly and many times also a flexed tail.

The relations between macrocytic anæmia and total depigmentation on one hand, and siderocytic anæmia and belly spot and flexed tail on the other, have remained obscure and constitute one of the most puzzling cases of pleiotropic action of genes[3,4]. It has been suggested that in siderocytic anæmia the primary effect might be the anæmia, the others being secondarily induced by a diminished oxygen transport to the tissues[5]. It is also stated, however, that "there is no foundation in observed facts for the assumption that variegation of the fur is physiologically conditioned by an anæmia"[3].

Nevertheless, it is known that some factors are common to both hæmoglobin formation and melanin production. Among these the factors belonging to the group B vitamins[6] and copper[7] are outstanding. As hepatic extracts have not cured mice with macrocytic anæmias[1] and the action of these extracts is generally associated with group B factors, it seems more likely that copper is the link between the two kinds of anæmias and pigmentation. In addition to the fact that copper is necessary for normal hæmoglobin production, it must also be remembered: (1) that copper is the co-ferment (or at least part of the co-ferment) of tyrosinase and polyphenoloxidases in general; (2) that one of the primary steps in the formation of melanins is, very probably, the oxidation of compounds with phenolic OH groups by tyrosinase or other phenolases; and (3) that the liver, important as an embryonal hæmatopoietic organ, and the hairs are relatively very rich in copper.

In spotted areas the cells of the hair matrices do not possess the Golgi structures (also called lipochondries) found in pigment-producing hairs[8]. Possibly this could be fixed early in embryonic life by the migration or non-migration of certain neural crest cells to the affected areas of the epidermis[9]. 15-day old mice embryos already show differentiation of their epidermis so far as concerns the hair follicles, as has been proved by cultures on chick allantois[10]. Only those agents acting prior to this time will be expected, therefore, to have an effect upon the production of localized or generalized white spotting. Macrocytic anæmia is known to be plainly manifest at the sixteenth embryonic day, and must have appeared several days before. Siderocytic anæmia is apparent at the thirteenth day of embryonic life, while the tail cartilage differentiates partially into fibres at the fourteenth to fifteenth day[1]. It seems very probable that the most severe, the macrocytic anæmia, will be found to appear by the twelfth day, when the primitive blood cells are replaced by intermediate (in the sense used by Grüneberg) and definitive erythrocytes.

As yet we have no data on the exact time of determination of the melanophores in hair follicles, or, which in the end is the same, on the time of differentiation of the Golgi structures characteristic of hair matrices capable of forming melanins. From what has been said above, it is reasonable to expect, however, that this differentiation (after migration, perhaps) will take place by the time that factors *W*, *W*^{v} and *f* exert their action. If so, a deficiency in a copper compound, necessary both to hæmoglobin production and to the synthesis of phenolase, will have the effect of causing anæmia and a lack of pigmentogenesis in the hair matrices now in differentiation. The difference between the actions of *W*, *W*^{v} and of *f* probably depends upon the time of action and the intensity of the two kinds of factors, the first acting more early and hindering, therefore, all differentiation of melanoblasts (in heterozygotes sometimes only partially), while by the time *f* comes into action only the melanophores of the median belly line would be yet undifferentiated. The flexed tail of the *ff* mice probably is a secondary effect due to the anæmia being at its peak exactly when the fibrous tail structures are differentiating. This seems more probable when it is considered that in mice several factors affe the tail as secondary effects.

The copper compounds upon which the primary action of *W*, *W*^{v} and of *f* is exerted will be perhaps related in the two cases. As the steps in the synthesis of copper proteins are not known, we must suppose that the compounds involved in the two anæmias and in depigmentation will be perhaps intermediates between ionic copper and cupro-proteins. The primary action of *W*, *W*^{v} and *f* would be a hindering, more transitory in *f*, of the synthesis of these compounds.

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Relation of the Thyroid to Infections

Izzo and Cicardo[1] have reported an inhibiting effect of thyroxine on experimental tuberculosis in guinea pigs. The experiments were suggested by the chemical resemblance of thyroxine to diploicin, which exerts a bacteriostatic action on *Mycobact. tuber.* But the authors envisaged also the possibility of an unspecifically stimulating effect of the thyroid as an explanation of their experimental results. I should like to direct attention to some earlier observations on the influence of the thyroid on infections in general and particularly on tuberculosis.

Kallos[2] reported on human cases of hypothyroidism suffering from severe pulmonary tuberculosis which exhibited a lowered sensitivity to tuberculin. Treatment with thyroid extract improved the condition and raised at the same time the tuberculin sensitivity. Later, Kallos and Müller[3] found that percutaneous tuberculin tests in general are liable to be intensified by the administration of thyroxine. Bettini[4] observed favourable effects of treatment with thyroid extract on laryngeal tuberculosis.

The observations of Kallos and Müller suggest rather a systemic stimulation of the defence mechanisms than a specific bacteriostatic action. An unspecific stimulation in infectious diseases was attributed to the thyroid in 1929 by Guillaume[5]. Lauber[6] achieved an increased resistance against acute infections by administration of thyroid extract, and Weichardt[7] an inhibition of growth of transplanted tumours. In typhoid patients, Reitler[8] observed a marked rise (two- to fourfold) of the O- and H-agglutinin titre after three days administration of small doses of thyroid extract (twice daily 0·025 gm.), while controls in the same stages of disease showed no titre change after so short a time. Larger and smaller doses had a less marked effect. Such an optimum has been described already by Thaddea[9] in respect of the increased erythro- and leucopœsis caused by thyroxine.

An unspecific factor is, therefore, certainly involved in the effect of thyroxine on the course of infections. As Weichardt thought, it is probably due to the increase in cellular metabolism (personal communication). But it may be that in the particular case of tuberculosis this unspecific stimulation combines with an antibiotic action on the causative organism.

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Chromosome Numbers in Cancer Cells

DURING an investigation on the variation of the chromosome system in human cancer of the uterus, we were able to observe frequently (in six epitheliomas of the uterus portio) a mitotic figure with a peculiar aspect of the chromosomes. In such cell divisions (which appear mixed with normal, heteroploid and polyploid ones) 24 chromosomes are present. Their shape resembles the meiotic one, being strongly contracted. The prophase shows thick threads, as in the pachytene stage, and later the synaptic males appear unsplit. No chiasmata are to be seen; the metaphase shows that every element is double.

It seems likely that the result of these divisions may be a reduction of the chromosome number. The cells in which the phenomenon appears are those termed *A* by Caspersson and Santesson[1].

This finding may be connected with the observation in 1906 of Farmer, Moore and Walker[2], and with that by Evans and Swezy[3]. But while the former is generally held to be doubtful, the latter concerns tetraploid cells, where the reduction to haploidy is impossible with a single mitosis. Haploid cells, on the other hand, were actually observed by Koller[4]. Finally, meiosis-like figures were found by Hearne Creech[5] in cultivated mouse fibroblasts previously treated with carcinogenic substances.

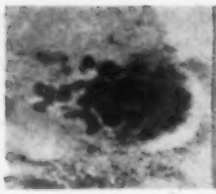

Fig. 1

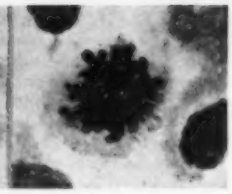

Fig. 2

Fig. 1. Metaphase plate in a cancer cell, with 24 paired chromosomes. Smear stained with acetocarmin. × *c.* 1,000

Fig. 2. Normal metaphase plate with 48 chromosomes. Note the size and differences of shape compared with the chromosomes of Fig. 1. Smear stained with iron hæmatoxylin. × *c.* 1,000

If the pairing chromosomes are unsplit in the early prophase, the phenomenon might be compared with the early leptotene according to Darlington, and the nuclear precocity might be explained as the result of the general upset of the nucleic acid cycle in the malignant cell already pointed out by Caspersson and Santesson[1].

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Chemical Composition of Egyptian Cow's Milk in Relation to Milk Laws

An investigation of the composition of cow's milk in Egypt has been undertaken through seven lactation seasons, from 1937 to 1944, involving 2,817 samples. The cows were those forming the herd of the Faculty of Agriculture; most of them were born and reared in the farm of the Faculty, and the rest were bought from lower Egypt. A wide variation in constituents has been shown, and this is due to the lack of particular breed and to the seasonal variations. The accompanying table shows the total average of milk constituents, their maximum and minimum, and the extent of increase and decrease above and below the average:

	Density	Fat	Solids (not fat)	Total solids	Water	Fat / T. solids
		%	%	%	%	%
Average	1·0315	4·87	9·11	13·98	86·02	34·72
Maximum	1·0375	9·25	10·57	18·73	89·76	50·80
Increase %	19·05	89·94	38·53	33·98	4·35	46·31
Minimum	1·0230	2·00	7·06	10·24	81·27	15·03
Decrease %	26·98	58·93	22·50	26·75	5·52	56·71

Owing to the great variations in the composition of milk it seems difficult to prove that a milk sample is adulterated by either adding water or separating cream. It is due to these wide individual variations that a genuine sample with a very low amount of fat can be considered legally adulterated according to the present milk regulations in Egypt. The present limits for cow's milk in Egyptian milk laws[1] are the same as those applied in Scotland, and all the conditions are quite variable. These laws state that if fat and solids-not-fat are less than 3 per cent and 8·5 per cent respectively, the sample is suspected of being adulterated. In Scotland, Tocher[2] found these figures after a study of 676 milk samples, in which case the average fat was found to be 3·95 per cent and average solids-not-fat was 8·78 per cent. He further found that fat of 56 samples (8·38 per cent of animals) was less than 3 per cent, and this is the least limiting figure to determine whether a sample was genuine or not. 167 samples (24·70 per cent of animals) also had solids-not-fat less than his average figure 8·5 per cent.

Our data show that the average fat content in the 2,817 samples was found to be 4·87 per cent. Out of this number of samples only 26, or 0·92 per cent, of the whole samples gave fat figure less than 3 per cent. The same happened in solids-not-fat, where the average figure was 9·11 per cent, and only 625 samples (22·15 per cent) showed less than 8·8 per cent. The lowest limiting figures of Tocher could therefore not be applied to Egyptian cow's milk. If the number of animals was taken into consideration, Tocher based his 3 per cent on 8·38 per cent of animals. On the same lines, from the fat distribution, it is worthy of note that 94 samples, or 3·33 per cent, showed fat content less than 3·5 per cent, and 219 samples, or 7·78 per cent, had a fat content less than 3·80 per cent. Hence, it is more reasonable in Egypt to consider the lowest limiting figure of fat nearly about 3·80 per cent, certainly not 3·0 per cent. As regards solids-not-fat, Tocher found that the average figure was 8·87 per cent, and the least limiting figure was 8·50 per cent for 24·70 per cent of animals. If such lowest figure was applied in our herd it would correspond to 8·01 per cent of samples; hence it is quite fair to consider the lowest limiting figure 8·80 per cent, which corresponds to 22·15 per cent of the samples.

It is therefore more correct to consider in the Egyptian milk regulations the lowest figure of fat to be 3·80 per cent and of solids-not-fat 8·80 per cent, instead of 3·0 per cent and 8·50 per cent respectively. To these can be added the total solids and the ratio of fat to total solids; the former should be 12·60 per cent and the latter 30·10 per cent.

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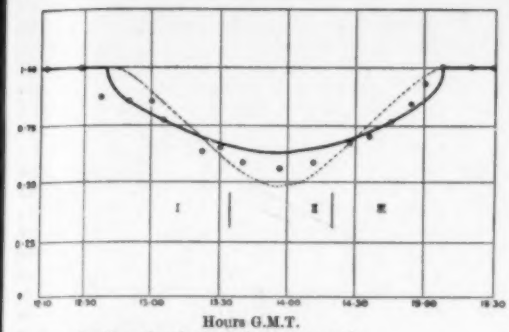
[1] "The Regulations of Milk Sale, Ministry of Interior D.P.H.", art. 2 (May 18, 1925).
[2] Tocher, J. F., "Variations in the Composition of Milk" (H.M. Stationery Office, 1925), 114–117.

Radio Noise from the Sun at 3·2 cm.

In connexion with Dr. Martyn's recent communication[1], the following measurements made by me at Malvern during the partial eclipse of July 2, 1945, may be of some interest. They were made at a wavelength of 3·2 cm., using an apparatus similar in principle to that described by R. H. Dicke[2] in conjunction with an antenna consisting of a wave-guide-fed paraboloid 3 ft. in diameter. The beam width was about 2°.

The results obtained are shown in the accompanying figure, together with two comparison curves. The full curve represents the fraction of the sun's circumference, and the dashed curve the fraction of area of the sun's disk exposed during the course of the eclipse.

The weather divided the experiment into three periods. During period I there was heavy cloud



——, fraction of sun's circumference exposed ;
- - - -, " " " area " ;
o, experimental points ;
Absolute value of sun's radiation = 4×10^{-13} watts/mc./s./cm.²

almost totally preventing visual alignment. A time constant of 1 sec. on the output meter rendered electrical alignment rather difficult, so errors due to misalignment may be present. In period II atmospheric absorption was appreciable, rain fell and eventually stopped measurements for a while. Measurements of atmospheric absorption were made together with the solar measurements, and correction applied, but the results may quite possibly be too low. In period III measurements were started again with visibility rapidly improving, and frequent visual sights were made.

Although the observed values do not fit one curve better than the other, there are at least two factors which must be considered. First, even if all the noise originates at the sun's circumference, the source would not be of infinitesimal width, and some rounding off of the sharp corners of the full curve would be expected. Secondly, it is to be expected that some noise comes from the whole disk, and the trough would thus be deepened to a certain extent. The accuracy of the measurements does not warrant much effort in deducing the detailed distribution of the noise sources, but they do indicate that the sources are mainly located about the circumference.

The value of the total radiation from the sun was found to be 4×10^{-13} watts/mc./s./sq. cm.

I wish to thank the Chief Scientist of the Ministry of Supply for permission to publish these results.

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Feb. 18.

[1] *Nature*, **158**, 632 (1946).
[2] *Rev. Sci. Instr.*, July 1946.

Crystal Structure of a Crossed-Chain Potassium Soap

It is generally assumed that hydrocarbon chains in soaps all lie parallel to each other, although experimental evidence on this point has hitherto been lacking. Soaps crystallize in a bewildering variety of crystalline forms[1], and whereas the axes of the chains may lie parallel in some forms, they do not necessarily do so in all of them.

In the case of potassium soaps, we have encountered at least three forms, provisionally designated *A*, *B*, *C* of anhydrous, and one form *D* of hydrated, neutral even-numbered potassium soaps, each giving a different characteristic *X*-ray powder pattern. The form *A* is monoclinic, and was obtained for soaps with 4–12 carbon atoms in the chain ; long spacings *d* measured in kX. obey a formula, $d = 5{\cdot}70 + 2{\cdot}165\,N$, where *N* is the number of carbon atoms in the chain. The angle of tilt between the chain axes and the (001) plane (calculated from the increment, assuming tetrahedral angle and carbon to carbon bond-length 1·54 kX. in the chain) is therefore 59·4°.

The form *B* is probably triclinic ; it was obtained for soaps with 12–18 carbon atoms per molecule. Long spacings obey the law $d = 6{\cdot}80 + 1{\cdot}95\,N$; the angle of tilt is therefore 50·7°.

The form *C* was observed only at higher temperatures, and the hydrated form *D* at lower temperatures ; they have not yet been studied in sufficient detail to warrant description. Piper[2] reports only one form each of neutral and acid potassium soaps, and the neutral soaps of longer chain-length investigated by him may be identical with our form *B*.

We were fortunate in growing a few single crystals of the monoclinic form *A* of potassium caprate ($KC_{10}H_{19}O_2$), large enough for a single-crystal X-ray examination, and prepared Fourier projections along the *a* and *b* axes. They revealed that in this form of soap the molecules are in general positions and the hydrocarbon chains cross each other at an appreciable angle.

The crystals were grown from ethanol by very slow evaporation over calcium chloride. They are extremely thin plates, the large face being {001}, with malformed edges. They are stable on exposure to the dry air, but disintegrate (probably forming the hydrated form *D*) when exposed to air of ordinary humidity at temperatures below room temperature. Dehydration experiments showed that they are anhydrous.

Rotation, oscillation and moving film photographs were taken about the *a* and *b* axes using copper $K\alpha$ radiation. The crystal is monoclinic and the unit cell dimensions are : $a = 8{\cdot}09$ kX., $b = 5{\cdot}63$ kX., $c = 28{\cdot}81$ kX., $\beta = 108°$, d (001) $= 27{\cdot}40$ kX. ; density (meas.) 1·123 gm./c.c., (calc.) 1·112 gm./c.c. (assuming four molecules per unit cell) ; halvings observed were : $(h0l)$ absent when h is odd, $(0k0)$ absent when k is odd ; therefore, the space group is $C_{2h}^5 - P\ 2_1/a$.

The intensities of the reflexions were estimated by eye and the signs of most of the structure factors determined by trial and error. In the Fourier projection along the *b* axis, the plane zigzag hydrocarbon chains project parallel to each other and edge on. Moreover, owing to a component of tilt in the plane perpendicular to the plane of projection, pairs of carbon atoms of the same chain overlap, with the exception of the terminal groups. The electron density distribution is consistent with the zigzag configuration, and, assuming the usual interatomic angles and distances, approximate *x* and *z* co-ordinates have been determined. The component of the angle of tilt projected along the *b* axis, measured from the *a*-axis, is approximately 102°. In the Fourier projection along the *a* axis the chains are seen face-on and form a criss-cross pattern, one chain making on the projection an angle of about 58° ; the other, in conformity to the symmetry of the crystal, an angle of about 122°, both measured from the *b*-axis. The co-ordinates of the atoms are being refined.

We are indebted to Dr. J. Iball for valuable advice, and to the director of the Chester Beatty Research Institute of the Royal Cancer Hospital (Free) for

the loan of some apparatus. We wish to thank the directors of Lever Brothers and Unilever Ltd. for permission to publish these results.

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[1] Buerger, Smith, Ryer and Spike, *Proc. U.S. Nat. Acad. Sci.*, **31**, 226 (1945).
[2] Piper, *J. Chem. Soc.*, 234 (1929).

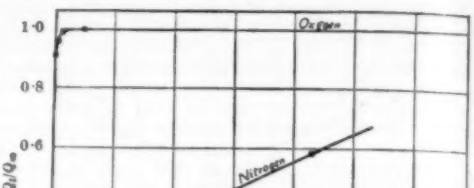
Molecular Sieve Action at Low Temperatures

By using crystalline network lattices with uniform interstices as sorbents, it has proved possible to carry out a great many resolutions of molecular mixtures[1]. Molecules which are of the right dimensions to enter and occupy the intra-crystalline interstices are then removed by selective sorption, leaving behind molecules which are too large or have the wrong shape, and hence toward which the network lattice is a non-sorbent. Crystalline parameters define with precision the dimensions of the interstices (which are linked to give channels); and, therefore, the molecular sieve action is equally clearly defined. As a result separations become quantitative in numerous instances (for example, *n*-paraffins from *iso*-paraffins using dehydrated chabazite as sorbent).

Between these two extremes lies a transition group of molecules which work their way slowly into the crystal by a process of activated diffusion[1]. Indeed, there is a complete range of velocities of sorption between the extremes. Some molecules are sorbed rapidly at room temperatures, but more slowly at −78° C. (for example, argon and nitrogen in calcium and barium mordenites). Then one finds a very low energy of activation for diffusion[2]. (This energy of activation is not due to chemical forces, but is a reflexion of the periodic potential energy field in the crystal encountered by the molecule as it moves from one site of maximum sorption potential to the next.)

It has now been found that the molecular sieve behaviour can be extended considerably by sorbing those gases with a small energy of activation for diffusion at still lower temperatures (−183° to −195° C.). In this way, for example, using a suitable molecular sieve sorbent, great differences in the sorption-rates of oxygen, nitrogen and argon were found, which seem quite sufficient to permit quantitative or semi-quantitative resolutions of their mixtures. The sorption-rates at − 184° C. were as expected in the order oxygen > nitrogen > argon, in the inverse relation to the dimension important for diffusion down a narrow interstitial channel, namely, the cross-sectional diameter normal to the molecular axis in oxygen and nitrogen molecules, and the diameter of the argon atom respectively[1,2].

As an illustration, the accompanying graph shows the relative amounts of argon, nitrogen and oxygen sorbed by 1 gm. of dehydrated levynite at − 184° C. at various times. Apart from a small and rapid sorption on external surfaces of the crystal powder, argon is sorbed at a very slow rate. Moreover, if a mixture of argon and oxygen were passed through the powder at − 184°, by adjusting the time of contact to one or two minutes, one would here expect a 99 per cent removal of oxygen from the mixture.



WIDELY DIVERGENT SORPTION-RATES IN DEHYDRATED LEVYNITE AT − 184° C., DUE TO THE MOLECULAR SIEVE ACTIVITY OF THE ZEOLITE

Q_t denotes c.c. sorbed at N.T.P./gm.
Q_∞ denotes sorption at equilibrium in c.c. at N.T.P./gm.; oxygen, 10·02 c.c./gm.; nitrogen, 9·77 c.c./gm.; argon, 10·13 c.c./gm.

Such contact times would also give a good separation of nitrogen from oxygen. These results, particularly on argon – oxygen mixtures, should be of interest to the argon industry, and the liquid air industry. The experiments also demonstrate for the first time that levynite, like chabazite[3], gmelinite[3], mordenite[3] and certain synthetic zeolites[4], has molecular sieve activity.

A full account of these and other results will be published elsewhere.

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[1] Barrer, *J. Soc. Chem. Ind.*, **44**, 130 (1945).
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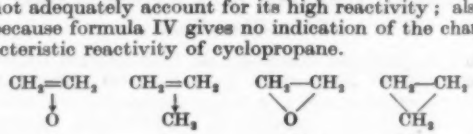
[3] Barrer and Ibbitson, *Trans. Farad. Soc.*, **40**, 195 and 206 (1944).
[4] Barrer and Riley, in the press.

Structures of Ethylene Oxide and Cyclopropane

It has recently been suggested by Walsh[1] that the structures I and II represent the properties of ethylene oxide and cyclopropane better than do the classical formulæ III and IV. In these new structures the oxygen atom in I, and the CH_2 group in II, are attached to the double bond by a dative link formed from the π-electron pair of the 'ethylene' portion of the molecule. These ideas were apparently put forward because Zimakov[2] has lately pointed out that the classical Würtz formula for ethylene oxide does not adequately account for its high reactivity; also because formula IV gives no indication of the characteristic reactivity of cyclopropane.



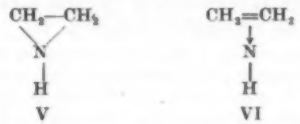
The conception of π-electron dative bonds is due originally to Dewar[3], and though it does help to explain certain molecular rearrangements, its use in the suggested structures makes it difficult to reconcile these with the known Raman and infra-red spectra

of ethylene oxide and cyclopropane. If the double bond in structures I and II has the properties usually associated with such a linkage, then both these compounds should show a strong Raman band (polarized) in the region of 1,600 cm.$^{-1}$ due to the $>C=C<$ vibration: in ethylene[4] this band occurs at 1,623 cm.$^{-1}$.

Both structures I and III belong to the point group C_{2v}; the irreducible representations for vibrations of this point group are $5A_1+3A_2+4B_1+3B_2$, of which all are allowed as fundamentals in the Raman spectrum, while the A_2 vibrations are forbidden in the infra-red spectrum. The A_1 vibrations in the Raman spectrum are polarized, hence if structure I were correct we should also get a band in the infra-red spectrum in the region of 1,600 cm.$^{-1}$. The Raman and infra-red spectra of ethylene oxide[5], and of the related ethylene sulphide[6], are well known; but there are no Raman bands near 1,600 cm.$^{-1}$ in the spectra of either of these compounds; and the observed spectra are in conformity with the requirements of the symmetry group C_{2v}.

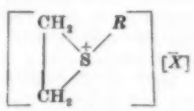
Cyclopropane as represented by structure IV belongs to the point group D_{3h}, which has as irreducible representations $3A_1' + 1A_1'' + 1A_2' + 2A_2'' + 4E' + 3E''$, of which the A_1'', A_2'', and A_2' vibrations are forbidden in the Raman spectrum and only the E' and A_2'' vibrations allowed in the infra-red spectrum. The A_1' vibrations in the Raman spectrum are polarized. The Raman and infra-red spectra of this compound have been examined by a number of workers[5], and the experimental results confirm these deductions. Again, no Raman line is found near 1,600 cm.$^{-1}$.

Further, and perhaps more conclusive evidence, could be obtained if the Raman and infra-red spectra of ethyleneimine V were examined; for if this compound has a π-electron dative bond as in VI, then the frequency of the N—H vibration should be different from the value usually found for this linkage when the nitrogen is part of a heterocyclic system.



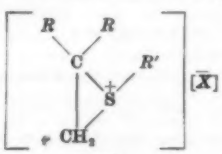
V VI

From the purely chemical point of view, there is also evidence against a π-electron dative bond in these substances, for Deléphine[7] has found that ethylene sulphide forms crystalline sulphonium compounds of the type VII.



VII

In this connexion it is interesting to note that the sulphonium ions of compounds of the type VIII



VIII

are asymmetric and should exhibit optical isomerism, since they are analogous to those organic sulphur compounds which have been successfully resolved[8]. In fact, if compounds like VIII were resolvable, it would be strong evidence against the occurrence of a π-electron dative bond in ethylene sulphide.

Thus, though structures I and II are suggestive, it is difficult to accept them as representing ethylene oxide and cyclopropane. In the case of the former there seems no reason, at the moment, to go beyond Zimakov's suggestion that it be regarded as a resonance hybrid in which structures IX and X predominate.

IX X

This would account adequately for the reactivity of this substance and yet be consistent with the known Raman and infra-red spectra. The reactivity of cyclopropane could also be ascribed to resonance between analogous structures.

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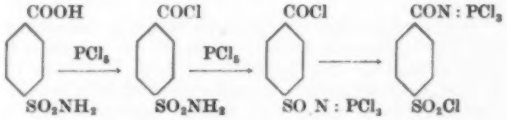
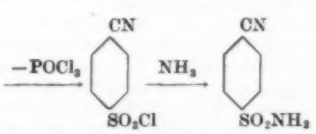
Feb. 25.

[1] Walsh, *Nature*, **159**, 164 (1946).
[2] Zimakov, *Acta physiochemica U.R.S.S.*, **21**, 401 (1946).
[3] Dewar, *J. Chem. Soc.*, 406 (1946).
[4] Herzberg, "Infra-red and Raman Spectra", 326 (van Nostrand, 1945). Full references to original work are given here.
[5] Lespieau and Grédy, *C.R. Acad. Sci. Paris*, **196**, 399 (1933). Timms and Mecke, *Z. Phys.*, **97**, 221 (1935). Ananthakrishnan, *Proc. Ind. Acad. Sci.*, **4A**, 82 (1936). Kohlrausch and Reitz, *Proc. Ind. Acad. Sci.*, **8A**, 255 (1938). Bonner, *J. Chem. Phys.*, **5**, 704 (1937). Linnett, *J. Chem. Phys.*, **6**, 692 (1938).
[6] Thompson and Dupré, *Trans. Farad. Soc.*, **36**, 805 (1940).
[7] Deléphine *C.R. Acad. Sci. Paris*, **171**, 36 (1920).
[8] Pope and Peachey, *J. Chem. Soc.*, **77**, 1072 (1900). Smiles, *J. Chem. Soc.*, 1174 (1900). Balfe, Kenyon and Phillips, *J. Chem. Soc.*, 2554 (1930).

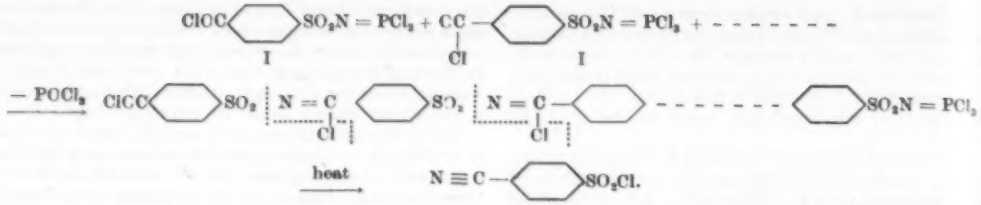
Action of Phosphorus Pentachloride on *p*-Sulphonamido Benzoic Acid

Remsen *et al.*[1], in the preparation of *p*-sulphonamido benzonitrile from *p*-sulphonamido benzoic acid by the action of phosphorus pentachloride, postulate the following mechanism of reaction:





They remark on the shift of the nitrogen from the sulphone group to the carbon atom attached to the para position of the ring, but do not explain it. The following explanation of the mechanism is offered.



It is supposed that several molecules of the chloride (I) condense as indicated to form polymers, phosphorus oxychloride being eliminated. The resultant polymer then breaks down on further heating, to give the required *p*-sulphonamido benzonitrile. In support of this hypothesis, compounds of the type $R.SO_2N{=}C(Cl)R'$ are known to dissociate on heating as follows[2,3,4]:

$$R.SO_2N{=}C(Cl)R' \rightarrow R.SO_2Cl + R'CN.$$

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Oxford. Feb. 5.

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[2] Wolkowa, *Ber.*, **5**, 139 (1872).
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A Proposed Test for 'Sterilized' Milk

THE need for a simple and satisfactory test to indicate the probable keeping quality and sterility of 'Sterilized' milk is becoming increasingly urgent. The phosphatase test of Kay and Graham may not always give satisfactory results when applied to 'Sterilized' milk because the reaction is affected by products produced in the milk as a result of the severe heat treatment.

The most common and important type of spoilage of 'Sterilized' milk is sweet curdling[1]. This fault may occur in bottles of milk with the vacuum unimpaired in as short a period as three days after sterilization. The organisms responsible are usually atypical forms of *B. cereus* and *B. subtilis* which produce a rennin-like enzyme and, also, because of the reduced oxygen tension in the milk, carbon dioxide. The heat treatment to which the milk is subjected (at least 212° F. for a period of not less than 10 minutes) causes a decrease in the amount of soluble calcium, but the carbon dioxide produced by the organisms renders sufficient of the calcium soluble for the rennin to clot the milk.

Types of spoilage which occur with less frequency are the development of 'oxidized' or 'cardboard' flavour due to the presence of large numbers of *B. circulans*, which also appears to produce a rennin-like enzyme in milk, and 'bitter' flavour which is produced by *B. thermoacidurans*.

It has been shown that the alcohol test can be used to indicate the keeping quality of raw milk, and that milk containing a large number of rennet-producing organisms can be detected by this test[2].

From these researches it appeared feasible that the alcohol test might be modified to indicate the keeping quality of 'Sterilized' milk. Preliminary experiments have shown that when milk containing spores of *B. subtilis*, *B. cereus* or *B. licheniformis* after sterilization is incubated at 37° C. for 27 hours and then tested by the alcohol test using 80 per cent (sp. gr. 0·848) alcohol containing 0·02 per cent neutral red, those samples which gave a precipitate developed bitterness or sweet curdling within a period of three weeks when held at room temperature, that is, the period within which the milk may be held before sale to the public. If in addition to the precipitate there is an acid reaction, it is probable that the milk is contaminated with streptococci which have gained entrance to the milk after heating, or with acid-producing sporing aerobes such as *B. albolactis* (Mig.) and *B. thermoacidurans*. These organisms are, however, not commonly found in 'Sterilized' milk. On the other hand, if the reaction is slightly alkaline, the contamination is probably due to spore-forming organisms present in the bottles before they were filled with milk.

These preliminary experiments will require to be extended in order to define the exact correlation between the results of the test and the keeping quality of the milk.

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[1] Morgan, G. F. V., *Proc. Soc. Agric. Bact.* (Abstracts), 31 (1943).
[2] Chalmers, C. H., *J. Bact.*, **15**, 93 (1928).

Influence of Heteroauxin on the Cotyledons of *Phaseolus vulgaris* L.

I THINK it is only right that attention should be directed to certain facts concerning the communication from A. Malabotti, published in *Nature* of December 14, 1946, under this title. The work described there, far from being recent, was carried out at the Biological Research Institute of the Academy of Science in Vienna more than ten years ago, when I was director of the Institute. Malabotti was one of my students, and the work was done at my suggestion and under my supervision to supplement my own experimental work on the same subject. Accounts of the work have already been published by Malabotti[1] and myself[2,3]. A comparison of Mr. Malabotti's communication in *Nature* with my paper of 1937 shows that it is an almost literal translation of the latter, with the addition of two photographs and their explanations.

Since 1939 I have been working at the Jodrell Laboratory at the Royal Botanic Gardens, Kew, and, during part of this time, have continued my researches on the effect of heteroauxin on *Phaseolus vulgaris*, a full account of which was published[4] with due acknowledgment to Malabotti for his past collaboration.

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Kew, Surrey.

[1] Malabotti, A., *Anz. Akad. Wiss. Wien, Math. Naturwiss. Kl.*, No. 13 (1937).
[2] Portheim, L., *Anz. Akad. Wiss. Wien, Math. Naturwiss. Kl.*, No. 17 (1936).
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SCIENCE AND THE REAL FREEDOMS

THE critical economic situation in which Britain finds herself requires all possible scientific help. The contribution of men of science can be as vital to our national recovery as any gains won by the miners in the battle for coal. But this depends on whether men of science are in a position to act, and whether their efforts are properly organised and integrated on a national scale.

The speakers at a recent conference on "Science and the Real Freedoms" convened by the Association of Scientific Workers dealt with these issues so far as they affect the freedom of men of science to develop their knowledge and the opportunity to see it applied to the main economic problems of the country. In opening the meeting, Sir Robert Watson-Watt pointed to the substantial progress that has been made towards the planning of scientific effort. Members of the Association particularly welcome the formation of the committees for military and civil science under the chairmanship of Sir Henry Tizard. Also encouraging are the scientific organisation within the National Coal Board and the provisions of the Industrial Organisation Bill. But still there remain severe limitations on the development and use of science, which we would be unwise to ignore.

The scale and nature of the effort applied to the development of new weapons of war, which offer us the possibility of mass destruction of quite unprecedented extent, is a source of disquiet. The man of science, as a key man in this development, works behind the screen of military security, cut off from free intercourse with other scientific workers by dangerously ill-defined and ill-conceived secrecy restrictions. The Official Secrets Act, which someone once quite seriously described as "the Act to repeal Magna Carta", is singularly unclear in the burdens, often of retrospective responsibility, which it puts on State servants and ordinary citizens alike. Safeguards are essential, but they should be specific, clear, comprehensible and limited. At present it seems that timid minds are imposing a stricter and more extensive secrecy than is necessary, with the result that our own scientific progress is perhaps hampered as much as that of a potential enemy.

Restrictions, Sir Robert said, are not confined to the military field. It is the habit of industrialists to accuse the bureaucrat of an exclusive taste for restrictions. However, they themselves must take some of the blame for certain economic shortcomings. For a long time sections of industry have imposed limitations on the development and interchange of new ideas and techniques, occupied research workers on circumventing the patents of others, and used blocking patents of their own to ward off the necessity of making new capital investments.

Talk on 'freedoms' has been too much directed to the passive freedoms, 'freedoms from'; and too little to the active freedoms, 'freedoms for' and 'freedoms to'. While men of science have been accustomed to claim for themselves the right to choose, to learn, to read, speak, think and write as they will, they have not put enough effort into the harder task of winning the freedom to investigate, to study scientifically within the industries themselves and by their own methods the problems which they consider important to the life of the community. The scientific worker in industry is seldom given the chance to investigate adequately the problems of production and development in his section of industry, nor is he in a position to undertake the full application of war-time discoveries to production techniques. There is clearly an urgent need of extension of freedom to penetrate in this direction.

Sir Robert Watson-Watt ended with a word of caution. It should be remembered that the outcome of any project of scientific research is unforecastable. As men of science we cannot say explicitly at the outset what may be expected from the investigations which we feel we must be free to undertake. The user does not know what to ask for; the investigator does not know what he can promise. But as to the great advantages which will arise from the organised application of research and scientific method, we have no doubts and many proofs. The opportunity which men of science now have of proving the value of their methods in overcoming our economic difficulties must not be lost.

Dr. E. H. S. Burhop, former member of the British team of atomic scientists in America, spoke of the loss of what might be called the natural rights of men of science. Such men have advanced fundamental knowledge in the past, because there have been free exchange of information and collaboration across frontiers and between workers in the different branches of science. Now secrecy has split them in camps, and the ominous delay in ending it is a symptom of the preparation of another world war. In view of the great dangers involved, the Association of Scientific Workers feels that it is time for men of science to decide what they can do collectively and individually to better this situation.

To one who has come to recognize a traditional fairness in British justice, some of the provisions of the Official Secrets Act are alarming. Under it the normal rights of citizens to a fair trial are superseded, and the onus of proof of innocence is placed on the accused. It is not necessary, Dr. Burhop said, for the prosecution even to prove that any specific offence has been committed; only that the character of the accused makes it appear probable that he has committed such an offence. Moreover, many people are under the misconception that this Act applies only to those in Government service. In fact it applies to everyone in the country.

We have, as a warning of what might happen, the hysteria and false accusations which followed the revelations of a spy-ring in Canada. There is also the case of Dr. Nunn May, which arose similarly out of the secrecy Britain and the United States have imposed on the atom bomb. While the Association does not condone his offence, to which he himself had pleaded guilty, it did feel justified in asking for a marked reduction in his ten-year sentence. If the harshness of this was intended as a deterrent on other men of science, it was a success in so far as it made many have second thoughts about taking any part at all in the development of atomic energy in Britain.

Dr. Burhop recalled the circumstances of the ban placed on certain British and American scientific workers from travelling to Moscow, when the war with Germany had ended, and the Japanese war was in its last stages. He doubts if any atomic physicist would even now have the temerity to apply for permission to travel to the U.S.S.R. or Eastern Europe. As new techniques of mass destruction are developed, the ban might involve other scientific workers besides the atomic physicists.

The Association advocates the complete publication of all results of scientific research, which has been suppressed for reasons of military security, as soon as the Security Council is operating a plan which outlaws the use of weapons of mass destruction, and which provides for a general reduction and control of armaments. Even while the present situation continues, secrecy should be confined to certain technical aspects of weapon development. As a means of re-establishing wide international relations, continued support for U.N.E.S.C.O. and for the recently formed World Federation of Scientific Workers is essential. Moreover, men of science, including those working on atomic energy, should be allowed and encouraged to visit workers in other countries.

We have to be vigilant concerning national restrictions on the freedom of men of science. Under the Atomic Energy Act scientific workers have no well-defined rights of access to scientific information connected in any way with atomic energy. Decisions on these matters depend on the Minister of Supply and his official advisers, and the effects of these decisions will have to be carefully watched. Wherever they work, men of science should have a legal right to the publication of their results. All should be employed on the basis of service contracts, in which are clearly defined their rights and duties in their particular job.

Prof. J. D. Bernal opened his address with the words: "The real freedoms of science not only include freedom from crippling restriction, but freedom to give of one's best in the service of the community. Such freedom is more than individual freedom. It is a collective freedom implying organisation of scientists by scientists in relation to all aspects of national activity."

There is nothing essentially new in the serious economic situation which confronts us to-day. As a culmination of our failure to organise and use our scientific resources efficiently, it has proved conclusively our worst fears and forecasts. Only men of science can see where and for what purposes they themselves are needed. It will be on their own initiative that they will take part in the national recovery.

The White Paper on the economic situation is no more than an able diagnosis of the trouble. When it comes to the cure, all it offers are pious hopes. Unless there is energetic planning, even the necessary minimum of a 40 per cent increase in exports will not be realized. On top of this the international situation looks as though it might get worse in the coming year.

In maintaining our present foreign policy we are keeping 1¼ million of our twenty million workers in the Armed Forces. About half a million more are engaged on the production of military supplies. The wastage is relatively greater when one considers our scientific man-power. At the present time about one half of the governmental scientific expenditure is allocated to military research, and clearly the ending of war preparations would release a larger proportion of scientific workers for productive work.

The essential and most urgent need is to consider the best way of organising scientific effort for helping to solve the short- and long-term problems facing us in the industrial sphere in Great Britain. We need a similar organisation and status to that of the operational research teams during the War. This is essential both in those Ministries responsible for our industries, and within the national development councils envisaged under the Industrial Organisation Act. In addition, men of science are needed at Cabinet office level working in co-operation with the Joint Planning Staff. The existence of the Tizard Committees provides the nucleus for such a scientific general staff.

In all this, it is clear that men of science can only analyse the situation and advise on the best policies to pursue. They can provide knowledge on which wise action could be based, but not the action itself. It is up to the Government to take adequate powers to ensure the implementation of the policies decided upon.

About the responsibilities of men of science, Prof. Bernal urged that they take active steps to ensure the widest possible knowledge of the technical situation of the country. The Tizard Committees cannot become fully effective in a normal Civil Service atmosphere, unless there is a possibility of mobilizing public opinion for research and against obstruction. It needs sustained activity on the part of scientific workers to see the necessary plans through to successful completion.

In the discussion, two delegates from the Amalgamated Engineering Union spoke of the attitude of the factory workers to scientific developments. The workers do not take kindly to innovations when, as in one factory, output was trebled but wages scarcely raised. Nor can they easily understand the attitude of the man of science, when he speaks of the importance of freely sharing his knowledge. In the artisan class, particularly, there is a tendency not to pass on information, since in times of unemployment only the most skilled and valuable men keep their jobs. It is necessary for the men of science to explain their methods and to prove their value to the working people. In that way they would win the willing co-operation of the trade union movement.

HEREDITARY (SEED-BORNE) SYMBIOSIS IN *CASUARINA EQUISETIFOLIA* FORST.

By Prof. S. R. BOSE
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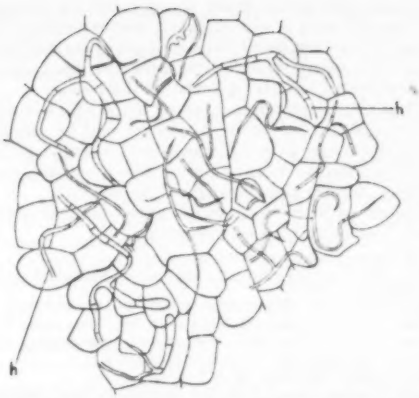
EVERY *Casuarina equisetifolia* plant examined has been found to have mycelia of *Phomopsis casuarinæ* F. Tassi extending throughout into every organ, beginning from the seed-coat. Cutting a section of the seed-coat of *Casuarina* and staining in picro-nigrosin or cotton blue one can see finely branched and septate hyphæ within the tegmen (see accompanying illustration). Only the resting embryo with two cotyledons is free from fungal infection. In samples of tomato and apple seeds from some apparently healthy fruits from Calcutta markets, I have seen a network of copiously branched and septate hyphæ in the tegmen under the microscope. Dennis[1] recently remarked that "fungi capable under favourable circumstances of parasitizing economic plants such as potato, tomato and apple may be found in nature as saprophytes on herbaceous weeds". I wonder whether Dennis had examined microscopically sections of clean seeds of the various economic plants to locate any possible *Phoma* hyphæ within the tegmen before planting them in the virgin soil. Oxley and Jones[2] found, under the epidermis of

maize seeds and seeds of many samples of English wheat and some Canadian wheat, abundant mycelia in the vegetative condition which they have not been able to identify nor to bring out in pure culture. In some samples of local wheat and maize seeds and some American maize, I have also obtained distinctly septate and branched hyphæ beneath the testa within the tegmen; from a maize sample *Ascochyta* sp. has been isolated in pure culture in malt agar tube, the seed germinated well in the course of five days and the fungus came out with two-celled, oblong and muticate conidia. Bessey[3] and Dennis[1] regard *Ascochyta* as essentially a *Phoma* with two-celled conidia. It would be of interest to know the function of these hyphæ within the seed coat, whether they have any connexion with germination and growth of the wheat and maize plants.

For a number of years I have had opportunities of examining roots, stems, green branchlets, cones, young fruits and fruit-stalks, seeds—young and mature—of *Casuarina equisetifolia* trees of different ages and from different areas of Bengal, Bihar, Orissa, Madras, Bangalore, etc., including a large number of healthy seedlings raised in the nursery of the Royal Botanical Garden, Calcutta, and later I received fruits, seeds and branchlets of *Casuarina equisetifolia* from Australia (Queensland and Brisbane), mainly through the kindness of Dr. J. McLuckie. In each case the same type of fungus (hyphæ of *Phomopsis casuarinæ*) was found co-extensive with the growth of the plant, occurring practically in every organ of the plant.

The results of my experiments with a number of seedlings of *Casuarina equisetifolia* in humus soil with pure culture of *Phomopsis casuarinæ*, as well as experiments to lower the physiological condition of pot-plants by keeping them confined within a glass chamber for about two weeks, confirm the observations of Melin[4] and How[5] that the physiological condition of the host determines the nature of relationship between the two partners in a mycorrhizal association; very weak seedlings in a moribund condition and pot-plants in abnormal condition were killed outright by the fungus, which became strongly virulent and parasitic, while slightly weak but normal seedlings were greatly invigorated by the fungal inoculation, thus establishing examples of well-balanced mycorrhizas. According to Roger Gosselin[6], *Polystictus circinatus* begins as mycorrhizal growth in the roots of spruce during the early period and stimulates the growth of the host plant; ultimately it travels towards the butt of the tree and produces butt-rot. He found that butt-rotted trees have a greater rate of growth than those not rotted, and could produce evidence of mycorrhizal association by inoculation of spruce seedlings with pure culture of *P. circinatus*. This case runs somewhat parallel to that of *Phomopsis casuarinæ* in *Casuarina equisetifolia*, where the fungus first begins as a symbiont but ultimately brings on death of the plant or, in cases, some of its parts, as a parasite; finally, it persists as a saprophyte to be succeeded by *Ganoderma lucidus*, *Fomes senex*, *F. durissimus*, *F. fastuosus*, *Polyporus calcuttensis*, etc., as members of a fungal complex.

Hahn's[7] experience with fruiting bodies of *Phomopsis juniperovora* on *Juniperus virginiana* was that, on vigorous plants growing in the open, the fungus could not be traced in spite of a careful and intensive search, but on suppressed cedars growing in a damp situation in the Platte River or on their withered and dead branchlet-tips the parasite could be found, and



PORTION OF THE TEGMEN OF SEED OF *Casuarina equisetifolia* SHOWING SEPTATE HYPHÆ (MARKED *h*) OF *Phomopsis casuarinæ*. CAMERA LUCIDA SKETCH AT TABLE-LEVEL WITH LEITZ EYEPIECE No. 5 AND OBJECTIVE No. 7. (× *c.* 275)

abundant fruiting was readily detected on blighted branchlets of a number of cedars used as hedge-plants and on transplant nursery stock used for ornamental purposes; all these observations led Hahn to suspect "if the cedar blight is seed-borne". In this connexion one might refer to the experience of Shear and Wood[8], who have demonstrated the presence of latent infection by *Glœosporium* and *Colletotrichum* in leaves, stems and fruits of a number of plants apparently healthy, and to the experience of Campbell and others[9] in oak heart-wood, where they frequently encountered a number of non-decay-producing fungi and some from apparently sound heart-wood; the exact cause of their presence cannot be ascertained, though it has been surmised that they might have some effect on entrance and subsequent spread of heart-wood-decaying species as forerunners of a fungal complex. Strasburger[10], discussing swellings on leaves of tropical plants belonging to the families of Rubiaceæ and Myrsinaceæ, due to infection by bacteria, has observed that these bacteria are present in the embryo of the plant, and that when these bacteria are artificially kept from the egg-cell, the development of *Ardisia* is abnormal. Parkin[11] has described a curious symbiosis between the fungus *Stereum sanguinolentum* and two siricid woodwasps; he asks why, of many and similar soft wood-attacking fungi, should *Stereum sanguinolentum* only be associated with these two woodwasps? Evidently these problems require further investigation.

Besides the fungus (*Phomopsis casuarinæ*), *Casuarina equisetifolia* bears coralloid roots or nodules due to infestation of the bacteria, *Rhizobium casuarinæ*, nov. sp. Dowson, which, according to A. Blake[12] and others, fix considerable quantities of nitrogen from the air. The roots of the plant also possess root-hairs at their growing ends. The fungus probably absorbs ammonia salts and complex organic nitrogen-compounds such as nucleic acid and peptone, and transfers them to the roots, as held by Melin[4]; probably auxins and vitamins accumulated by hyphæ are translocated to the roots (cf. MacDougal and Dufrenoy[13]), and the molecular nitrogen fixed by bacteria (amino-acid) is probably made available throughout the body of the plant; the fungus in return gets its supply of carbohydrates from the tree and of phosphatids exuded by its roots. The evidence

for nitrogen-fixation from the air by the fungus is very meagre and is not of much consequence. Thus, it is a clear example of close co-operation among the three—the plant, the fungus and the bacteria—for successful and healthy growth of the tree.

I think future work may show if the much discredited mycoplasm theory of Eriksson will be explained by the discovery of hereditary (seed-borne) symbiosis in many plants where a perennial mycelium can be detected within the tegmen of the seeds.

Details of this work, with experimental observations, will be published elsewhere.

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[12] Blake, A., Oxford Forestry Mem., No. 14, 5 (1932).
[13] MacDougal, D. T., and Dufrenoy, J., *Plant Phys.*, **19**, 440 (1944).

ELECTROSTATIC HAZARDS IN INDUSTRY

THE Institution of the Rubber Industry organised a forum to discuss "Electrostatic Hazards in Industry" on December 9 at the James Watt Memorial Institute, Birmingham. Mr. W. E. Madge (Dunlop Rubber Company) was in the chair, and the proceedings opened with five short papers each dealing with a particular aspect of the electrostatic hazard.

Mr. S. H. Wilkes (H.M. Senior Chemical Inspector of Factories), in his introductory remarks, dealt with the general principles to be borne in mind when considering electrification of materials and the consequent fire or explosion hazard. Inflammable materials—vapour, gas, or finely divided suspensions of dust—ignite only when the concentration lies within certain limits. Within this inflammability range, ignition may be caused by a rise in temperature of only a part of the system or by an electrostatic discharge. The obvious steps to take in minimizing the probability of ignition include the control of concentration and the elimination of the igniting source. Mr. Wilkes emphasized that the former must be considered of first importance; the elimination of explosive concentrations is more easily achieved in practice than the removal of all possible sources of ignition. At the same time, all reasonable steps must be taken to eliminate the occurrence of dangerous amounts of static by earthing securely all conductors, and by installing conductors instead of non-conductors wherever this is practicable.

Dr. F. J. Llewellyn (University of Birmingham) underlined the need for comprehensive laboratory data concerning the electrification and electrostatic ignitibility of substances likely to be met with in industry. Dealing with the theoretical side of ignition of dust clouds by means of electrostatic discharges, he mentioned a possible correlation between the energy stored in a condenser, the rate of dissipation, the voltage-time and current-time characteristics of the resulting air discharge and its incendivity. Discharge from a 0·01 mfd. condenser when no resistance, other than the leads and the spark gap, is included in the circuit produces an oscillatory current in the gap. The inclusion of a small resistance, say 500 ohms, completely removes this oscillatory nature; at the commencement of the spark, the current rises steeply to a high value, thereafter falling exponentially with time; the voltage meanwhile drops at the commencement of the spark to a low value and remains fairly constant until the spark ceases. The duration of the spark becomes progressively larger as this resistance increases, and the proportion of the condenser energy liberated in the spark rises to a maximum of about 30 per cent at 50,000 ohms, thereafter falling with increasing resistance. The ignition of dust clouds is most easily accomplished with sparks of short duration and high energy, that is, those obtained by discharging a condenser through a resistance of the order of 50,000 ohms.

Mr. G. Morris (Imperial Chemical Industries, Ltd., Explosives Division) discussed the electrification of powders in free-fall under gravity (Morris, *Proc. Phys. Soc.*, **51**, 1010; 1939) and also the ignition of heaps of powder by electrostatic sparks. The criterion of ignition is the energy stored in the condenser ($\frac{1}{2}CV^2$), and for small condensers is independent of the capacity. In laying down safety conditions for dealing with explosive powders, Mr. Morris found that 0·05 times the 50 per cent ignition energy gave a reasonably satisfactory upper limit for permissible electrification.

Mr. Fordham Cooper (H.M. Electrical Inspector of Factories) spoke of the causes of electrification in liquids during handling and movement. The boundary of an electrolyte such as water is normally highly polarized, having an electrical double layer, the inner and outer sides of the skin being oppositely charged. Anything which disturbs this surface will upset the electrical balance, with resultant separation of the positive and negative charges. Normally, any charges produced by the disturbance of a liquid will disappear by conduction if the specific resistance is less than 10^{10}–10^{12} ohms. The electrification of non-electrolytes presents a difficult problem; the probable explanation lies in the existence of traces of ionic or colloidal material in the liquid. Thus polar liquids such as alcohol or nitrobenzene are particularly susceptible to electrification. Mr. Cooper dealt also with the implication of stirring, and the addition of soaps; and suggested the following as precautions against fire and explosion: (*a*) increase conductivity of solvents; (*b*) use high flash point solvents; (*c*) earth all metal work, bonding discharging to receiving vessels; (*d*) keep up the air humidity; (*e*) do not introduce earthed or even unearthed conductors near the free surface of a liquid.

Mr. D. Bulgin (Research Division, Dunlop Rubber Co., Ltd., Birmingham) discussed the special electrostatic problems associated with rubber. Since the specific resistance of rubber lies between 10^9 and 10^{16} ohms, the leak-away time of static charges is very great; discharge may proceed either as a series of feeble sparks or as a brush. Whereas this direct discharge is usually of insufficient energy to cause ignition of inflammable vapours, induced charges on nearby conductors can become a serious hazard. Mr. Bulgin outlined the various methods available for minimizing this risk, both in the production of rubber goods and in their utilization. He described also a valve-voltmeter which he has designed (*J. Sci. Instr.*, **22**, 8; 1945) which is extremely valuable in detecting

the build-up of electrostatic voltages and in surveying rapidly the electrification produced at various stages in the processing of a material.

The five papers will be fully published elsewhere in due course.

CENTENARY OF KING'S COLLEGE (LONDON) ENGINEERING SOCIETY

THE Engineering Society of King's College, London, celebrated the centenary of its foundation during March 5–8. It is thus one of the oldest institutions of its kind in Great Britain, for its first meeting was preceded by only six days by the inauguration of the Institution of Mechanical Engineers. The oldest engineering institution in Great Britain, the Civil Engineers, was formed in 1818 and received its Royal Charter in 1828; the Société des Ingénieurs Civils de France was not formed until 1848.

The celebrations opened on March 5 with a thanksgiving service in the College chapel, conducted by the chaplain, the Rev. S. H. Evans, which was addressed by the Very Rev. W. R. Matthews, Dean of St. Paul's, himself a fellow of the College. This was followed by an address "King's College Engineering Society 1847–1947", delivered by Prof. S. J. Davies in the Great Hall.

Prof. Davies began by reading the resolution passed by the eleven original members on February 2, 1847: "Resolved that a Society be formed under the sanction of the Principal and with the patronage of the Professors of King's College, London, to be called the King's College Engineering Society, and that its object be to take in the various scientific and engineering periodicals of the day and that it be hereafter extended to the reading of original papers, giving prizes . . ."

By the end of 1847 nine papers, on subjects ranging from the Niagara Falls to the solution of algebraic equations, and from daguerreotype to coal gas, had been read. The practice of electing every term a committee and officers from the students was also established.

It is interesting to note that both Prof. Wheatstone, well known for his work on electric communications, and who held the chair of experimental philosophy, and Prof. Daniell, known by his hygrometer and the Daniell cell, who held the chair of chemistry, were among the early teachers in the Department. The subjects taken covered the very wide range of engineering, applied science and architecture. The development of the undergraduate studies has been towards specialization in civil, electrical and mechanical engineering, architecture being discontinued in 1912 and metallurgy in 1918.

There has been a remarkable continuity in the progress of the Society. Apart from the First World War, there have been only two short interruptions. The first was when a Mr. Gilbert moved an amendment, to a proposition dissolving the Society, to form a "Shakespearian and Dramatic Society". This was none other than W. S. Gilbert, of Gilbert and Sullivan fame. This break lasted only two years, however, and the Society was restored to health.

As stated before, one of the objects of the Society is to provide an opportunity for members to read papers of engineering and allied interest. In the last hundred years, more than 1,100 papers have been read, an average of eleven a year. The practice of awarding prizes for papers was instituted in 1871, and it has been the practice to award two prizes every year since. A third prize, to commemorate the services to the Society of the late Prof. Ernest Wilson, to be awarded for the year's best paper, was established in 1932.

Many former students and members of the Society have risen to eminence in their profession; of eighty-two presidents of the Institution of Civil Engineers, ten have been King's 'engineers'. There have been occasions when King's 'engineers' have achieved fame in other fields; W. S. Gilbert and C. K. Bird, or "Fougasse", of *Punch*, are notable examples.

In concluding his history of the Society, Prof. Davies mentioned the *King's Engineer*, which has been published annually under the joint auspices of the Society and of the Engineering Branch of the Old Students' Association.

Prof. Davies ended his address with some remarks on engineering training in general. In particular, he compared the size of technical schools in Britain with those in Germany; he believes that better results are obtained when the engineering faculty continues as a numerically small unit within the larger body of a college.

DEW IN PALESTINE

AN account has been received from Mr. S. Duvdevani, of the Palestine Meteorological Service, of an optical method of estimation of dew which he has developed at the Dew Research Station, Pardess Hanna Agricultural School, Karkur, Palestine. The need was felt for a much quicker and less costly method than that of direct weighing of the dew collected on a standard surface, so that a network of voluntary observing stations could be organised for a country-wide study of the amount of dew in the different seasons. In a dry climate such as that of Palestine, the success of certain crops is largely dependent upon the amount of dew, and the justification for measurements with apparatus not likely to give a high degree of accuracy, in which the personal factor may be rather prominent, is obvious. Agriculturists clearly wish to know primarily where the regions of most abundant dew at the seasons when this is most important are to be found. They care comparatively little about small errors in the absolute values of the figures for the amount of dew.

The optical method arrived at after ten years of study consists in exposing a standard wooden block, called the dew-gauge, at a standard height in the open, from sunset to sunrise. Dew is estimated by reference to a standard atlas of photographs, with which the size, form and distribution of the drops on the gauge is compared. Calibration was based on a preliminary study of the measured weights of dew for various types of drop distribution recorded on life-size photographs of the gauge, a selection of which is doubtless reproduced in the atlas.

A specimen Quarterly Dew Statement published by the Palestine Meteorological Service shows that in 1946 the totals for June varied more than those for April, ranging from about 7 mm. at Ramot Ha Shavim to practically nil at Jericho. If the year was not a very unusual one meteorologically, the conclusion to be reached is that, in the Rift Valley, crops get very little assistance from dew between April and June, even when there are many clear nights, and that coastal and hill country get dew on a scale unknown in the cloudy climate of England.

E. V. NEWNHAM

FORTHCOMING EVENTS

Other entries for April 14—April 19 will be found in the issue of *Nature* dated April 5

Tuesday, April 15

ROYAL STATISTICAL SOCIETY, NORTH-EASTERN GROUP of the INDUSTRIAL APPLICATIONS SECTION (at Lemington Glass Works, Ltd., Lemington-on-Tyne), at 7 p.m.—"The Application of Statistical Control to the Quality of Blown Glass-ware".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM AND DISTRICT GROUP of the INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Discussion on "Standardisation".

Friday, April 18

ROYAL INSTITUTE OF CHEMISTRY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 3.15 p.m.—Prof. H. J. Emeléus: "Some Aspects of Nuclear Chemistry"; at 5.15 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT IN STATISTICAL RESEARCH—The Secretary of the Faculty of Economics and Politics, Marshall Library, Downing Street, Cambridge (April 19).

LECTURER IN MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (April 25).

LECTURER IN SOCIAL SCIENCE—The Registrar, University College of Swansea, Singleton Park, Swansea (April 26).

TECHNICAL ASSISTANT (temporary) in the Farm Economics Branch of the Department of Agriculture for Scotland—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting No. G.96/47A (April 30).

LECTURER IN THE ECONOMICS OF COLONIAL AGRICULTURE, with special reference to co-operation, marketing and credit—The Registrar, The University, Oxford (April 30).

DIRECTOR OF PHYSICAL RESEARCH in the Admiralty—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1853 (May 8).

READERSHIP IN CHEMICAL PATHOLOGY tenable at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 14).

SIR T. D. OWEN PROFESSOR OF ELECTRICAL ENGINEERING—The Secretary and Registrar, University College of North Wales, Bangor (May 17).

CHAIR OF BOTANY—The Registrar, University College, Leicester (May 17).

CHAIR OF CHEMISTRY tenable at King's College of Household and Social Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 21).

READERSHIP IN CHEMICAL PHYSIOLOGY tenable at the Royal Free Hospital School of Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 29).

BETTY BROOKES RESEARCH FELLOWSHIP—The Whitley Professor of Biochemistry, University Museum, Oxford (May 31).

DRAUGHTSMAN in the Survey Branch, Tithe Redemption Commission—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1843 (May 31).

LECTURER IN BIOCHEMISTRY—The Professor of Biochemistry, University of Alberta, Edmonton, Alberta, Canada (May 31).

OLIVER GATTY STUDENTSHIP for the encouragement of research in the application of physical methods to biological problems—The Registrary, University Registry, The Old Schools, Cambridge (June 1).

TRAVELLING FELLOWSHIP IN GEOGRAPHICAL RESEARCH—The Director and Secretary, Royal Geographical Society, Kensington Gore, London, S.W.7 (June 1).

READERSHIP IN MEDICAL PARASITOLOGY tenable at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 2).

PROFESSOR OF INDIAN HISTORY AND ARCHÆOLOGY in the University of Madras—The General Department, Office of the High Commissioner for India, India House, Aldwych, London, W.C.2 (Madras, June 16).

RITCHIE CHAIR OF ECONOMICS in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (June 30).

LECTURER (Grade II) and an ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF APPLIED MATHEMATICS—The Registrar, The University, Liverpool (July 1).

GEOLOGIST to carry out general geological surveys and special hydrological and soil erosion studies—The Sudan Government Agent, London Office, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Geologist' (July 1).

UNIVERSITY LECTURER IN JAPANESE—The Secretary, Faculty Board of Oriental Languages, 167 Huntingdon Road, Cambridge (July 1).

ENGINEERING TEACHERS, both junior and senior and in various branches, by the Departments of Civil Engineering and of Mechanical Engineering—Dean J. J. O'Neill, Faculty of Engineering, McGill University, Montreal 2, Quebec, Canada.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Empire Cancer Campaign. Twenty-third Annual Report, 1946. Edited by J. P. Lockhart-Mummery. Pp. 186. (London: British Empire Cancer Campaign, 1946.) [301]

Proceedings of the Royal Irish Academy. Vol. 51, Section A, No. 2: The Calibration of a Photo-electric Nucleus Counter. By P. J. Nolan and L. W. Pollak. Pp. 9–32. 2s. Vol. 51, Section A, No. 3: A Theorem in the Charge-Symmetrical Meson Theory. By W. Heitler. Pp. 33–40. n.p. Vol. 51, Section A, No. 4: The General Affine Field Laws. By Erwin Schrödinger. Pp. 41–50. 1s. Vol. 51, Section B, No. 4: Quantitative Evolution, 8, Numerical Analysis of Tables to illustrate the Geological History of Species Number in Diatoms; an Introductory Summary. By James Small. Pp. 53–80 + 3 plates. 2s. 6d. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [301]

Ministry of Transport. International Meeting on Radio Aids to Marine Engineering, May 1946. Vol. 2: Radio Navigation, Radar and Position Fixing Systems for Use in Marine Navigation. Pp. vi + 190. (London: H.M. Stationery Office, 1946.) [301]

British Standards 1340–43: 1946. Drawing Papers (Tracing, Detail and Cartridge). Pp. 12. (London: British Standards Institution, 1946.) 2s. net. [301]

A New Notation for Organic Chemistry and its Application to Library and Indexing Problems. By Dr. G. Malcolm Dyson. Pp. 28. (London: Royal Institute of Chemistry, 1946.) [311]

Éire: Roinn Talmhaíochta (Department of Agriculture): Brainse Iascaigh (Fisheries Branch). Statistics of Salmon, Sea Trout and Eels captured during each of the Years 1945, 1943, 1941, 1939, 1937, 1935. (P. No. 7837.) Pp. 18. (Dublin: Stationery Office, 1946.) 6d. [81]

Council for the Preservation of Rural England, Sheffield and Peak District Branch. Annual Report 1946. Pp. 18. (Sheffield: Council for the Preservation of Rural England, Sheffield and Peak District Branch, 1946.) [81]

Birkbeck College (University of London). Calendar for the Year 1946–47. Pp. 198. (London: Birkbeck College, 1947.) [81]

Other Countries

Union Internationale de Chimie. Comptes rendus de la reprise de contact du bureau, du conseil et des commissions, à l'issue de la seconde guerre mondiale, Londres, 24–27 juillet 1946. Pp. 64. (Paris: Union Internationale de Chimie, 1946.) [1213]

Annals of the New York Academy of Sciences. Vol. 46, Art. 6: Blood Grouping. By William C. Boyd, J. W. Cameron, L. K. Diamond, Philip Levine, M. Melin, J. L. Oncley, Louis Pillemer, D. A. Richert, Eve B. Sonn, A. S. Wiener and Ernest Witebsky. Pp. 883–992. Vol. 47, Art. 3: Proteins and Protein Hydrolysates in Nutrition. By James B. Allison, John A. Anderson, Richard H. Barnes, David K. Bosshardt, Bacon F. Chow, Co Tui, Robert Elman, L. L. Miller, John P. Peters, F. S. Robscheit-Robbins, Robert D. Seeley and G. H. Whipple. Pp. 241–374. Vol. 48, Art. 3: Polyelectrons. By John Archibald Wheeler. Pp. 219–238. Vol. 48, Art. 4: The Effect of Artificially Altered Length of Day on Molt in the Silver Fox. By Charles F. Bassett. Pp. 239–254. (New York: New York Academy of Sciences, 1946.) [1213]

Research Council of Alberta. Report No. 48: Geology and Coal Occurrences of Wapiti-Cutbank Area, Alberta. By J. A. Allan and J. L. Carr. Pp. 46. (Edmonton: King's Printer, 1946.) 50 cents. [1613]

Yale Anthropological Studies. Vol. 2: Outline of Cultural Materials. Prepared by George P. Murdock, Clellan S. Ford, Alfred E. Hudson, Raymond Kennedy, Leo W. Simmons and John W. M. Whiting. Pp. vii + 56. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1945.) 6s. 6d. net. [1613]

Universidad de Buenos Aires: Facultad de Agronomía y Veterinaria, Instituto de Fruticultura y Silvicultura. Tomo I, Fascículo 5: Ensayos sobre germinación del polen de manzanos en un medio artificial. Por Jorge R. Díaz. Pp. 104. (Buenos Aires: Universidad, 1946.) [1713]

Cawthron Institute, Nelson, New Zealand. Annual Report, 1945–46. Pp. 39. (Cawthron: Cawthron Institute, 1946.) [1713]

The University Library: its Function and Potentialities. Inaugural Address delivered in Durban on 2 September 1946. By Dr. Herbert Cobians. Pp. 16. (Durban: Natal University College, 1946.) [1913]

Union of South Africa: Department of Mines. Geological Series, Bulletin No. 16: Waterberg Coalfield—Records of Boreholes 21 to 40 sunk for the Department of Mines. With Notes by J. F. Cilliè and H. N. Visser. Pp. 132. (Pretoria: Government Printer, 1946.) 3s. [1913]

Publications of the Dominion Observatory, Ottawa. Vol. 13: Bibliography of Seismology. No. 19: Items 6047–6142, January to June 1946. By Ernest A. Hodgson. Pp. 315–330. (Ottawa: King's Printer, 1946.) 25 cents. [3013]

Transactions of the San Diego Society of Natural History. Vol. 10, No. 17: The Glossy Snake, *Arizona*, with Descriptions of New Subspecies. By Laurence M. Klauber. Pp. 311–398 (plates 7–8). (San Diego, Calif.: San Diego Society of Natural History, 1946.) [3013]

Department of Agriculture, Canada. Annual Report of the Forest Insect Survey, 1945. Pp. 68. (Ottawa: Department of Agriculture, 1946.) [3013]

Research in Canada: Planning for the Coming Years. Papers given at the Symposium of the Chemical Institute of Canada, Quebec City, June 1945. Pp. vii + 160. (Sarnia, Ont.: Imperial Oil, Ltd., 1946.) [3013]

Catalogues

The Bulletin of the House of Johnson, Matthey and Co. Ltd. Vol. 1, No. 1, October-November 1946. Pp. 24. Vol. 1, No. 2, December 1946–January 1947. Pp. 24. (London: Johnson, Matthey and Co., Ltd., 1947.)

Marmite Yeast Extract in Medicine and Dietetics. New edition. Pp. 8. (London: Marmite Food Extract Co., Ltd., 1946.)